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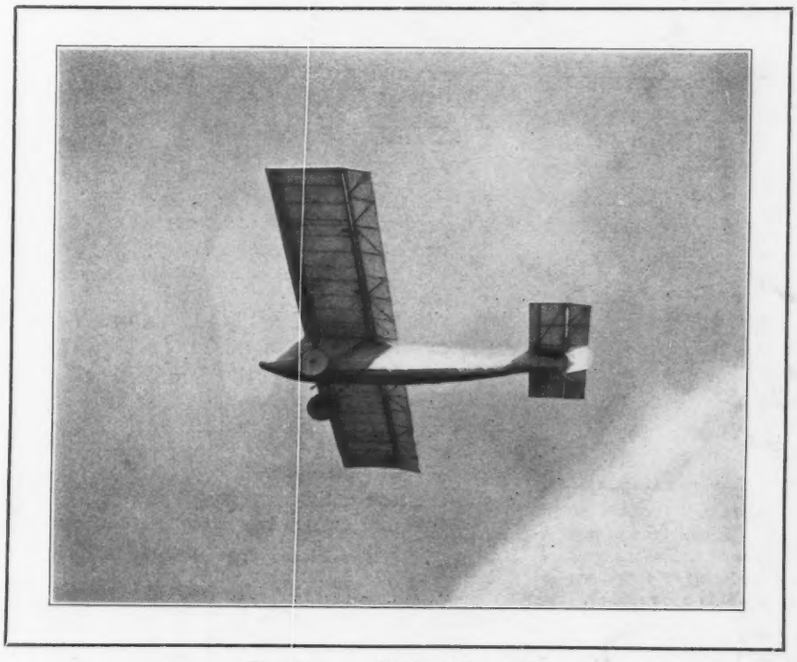

THE SECOND M. I. T. GLIDER

NOVEMBER, 1922

VOL. III MASSACHUSETTS INSTITUTE OF TECHNOLOGY NO. 5

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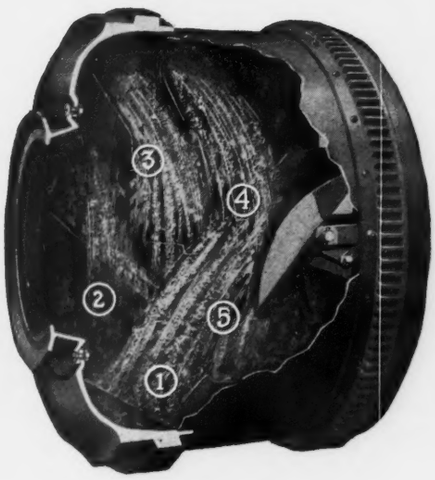

(1) Blade cuts through materials with churning action. (2) Blade carries materials up, spilling down again against motion of drum. (3) Materials hurled across diameter of drum. (4) Materials elevated to drum top and cascaded down to reversed discharge chute which (5) with scattering, spraying action, showers materials back to charging side for repeated trips through mixing process.

TESTS made at Purdue University by Professor W. K. Hatt prove that plasticity of concrete depends on the proper mixing. To obtain this plasticity in the minimum time, the individual particles of cement, sand and stone must be so mixed that they will find their proper position in the concrete. Then the cement acts as a lubricant and the concrete will be plastic and easy to work, instead of harsh and difficult to place.

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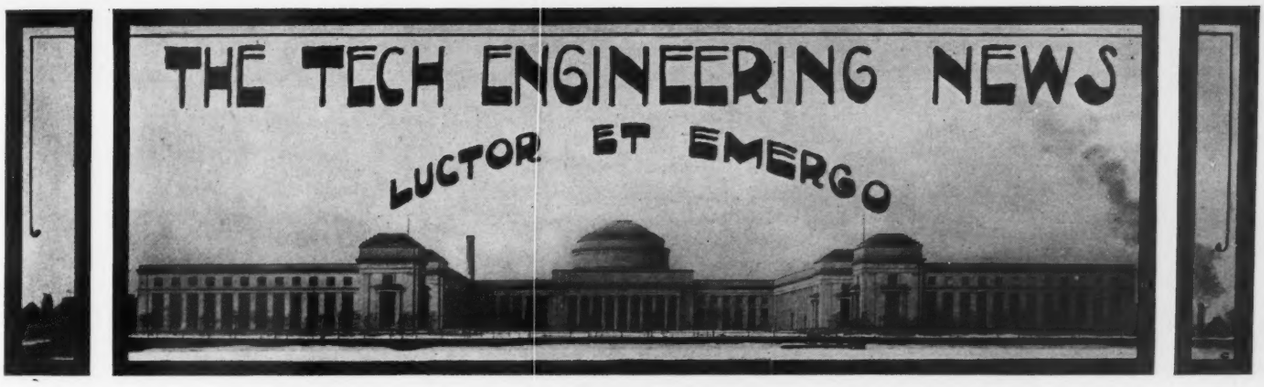

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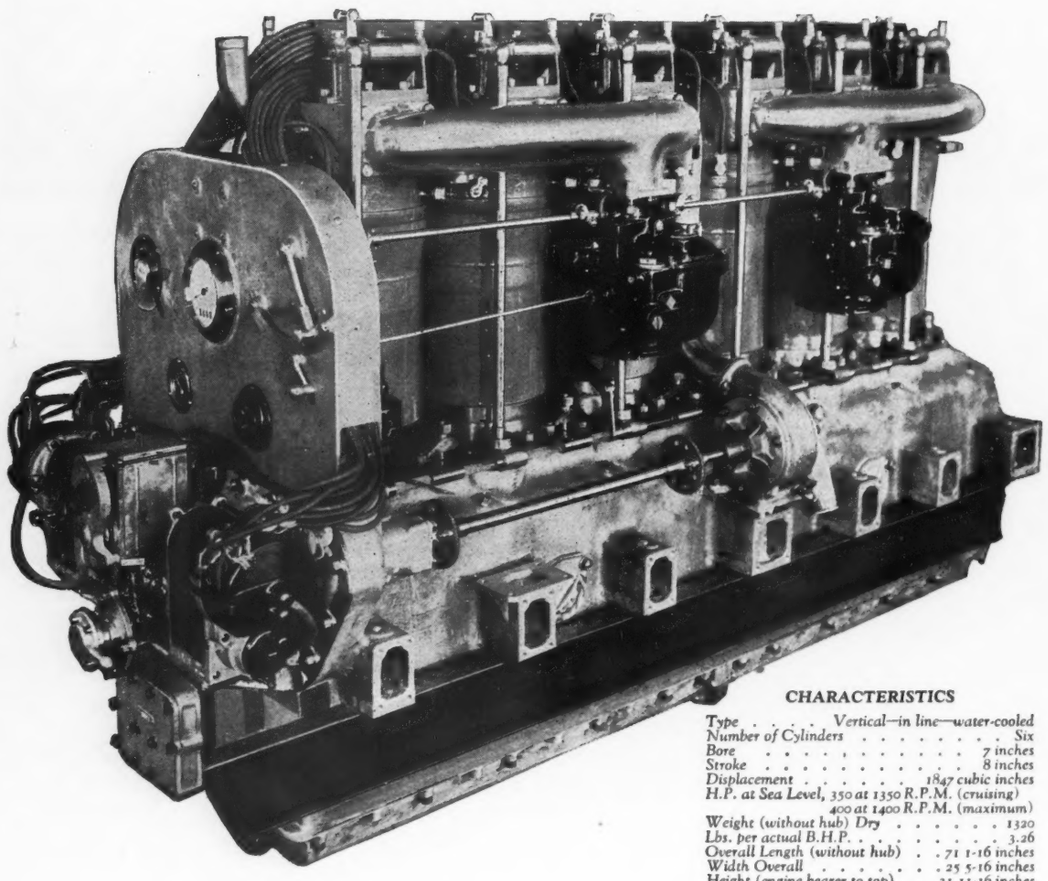
Table of Contents

	Page
SHOULD TECHNICAL EDUCATION BE AMELIORATED? By Prof. William S. Franklin	137
THE GROUNDS AND THEIR DEVELOPMENT. By H. J. Carlson, '92 (*A Technology Series Article*)	138
INDIRECT CALORIMETRY AND ITS APPLICATIONS. By Prof. H. M. Smith	140
THE ERECTION OF THE RADIO CENTRAL TOWERS. By David S. Fine	142
TERMINAL SERVICE PROBLEMS. By J. Rowland Bibbins	144
THE AMERICAN SAILPLANE. By Frank M. Gentry, '23	145
DR. SAMUEL WESLEY STRATTON. By George K. Burgess, '96	146



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Type	Vertical—in line—water-cooled
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Bore	7 inches
Stroke	8 inches
Displacement	1847 cubic inches
H.P. at Sea Level,	350 at 1350 R.P.M. (cruising)
	400 at 1400 R.P.M. (maximum)
Weight (without hub) Dry	1320
Lbs. per actual B.H.P.	3.26
Overall Length (without hub)	71 1-16 inches
Width Overall	25 5-16 inches
Height (engine bearer to top)	31 11-16 inches
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THE TECH ENGINEERING NEWS

THE PROFESSIONAL JOURNAL OF THE ALUMNI AND UNDERGRADUATES OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

VOLUME III NOVEMBER, 1922 NUMBER 5

SHOULD TECHNICAL EDUCATION BE AMELIORATED?

By PROFESSOR WILLIAM S. FRANKLIN

Professor of Physics, Massachusetts Institute of Technology

Inheritance of wealth and of position-in-life has developed in us all an abhorrence for every kind of ordeal or test of young men, and this abhorrence permeates every college in the land. It were better for us to go back to the terrible ordeals of the Wild Indian. "What, my son swing on raw-hide thongs sewed through the muscles of his breast and back?" asks your smug place-worshiper. Yes, you mere pretense of an aristocrat, yours! You had thought to place him unprepared and untried, had you? and the wonder of it is that you can so place him, but his grandchildren, never.

Most of my life has been spent as a teacher in the technical school, and teaching is great fun in spite of, or, I should say, in all honesty, partly because of delinquent students and their softened fathers and tearful mothers. From their point of view, technical education certainly should be ameliorated. How often I have faced a real condition with a young man only to have him and his fond parents assume that a favor on my part would alter or even greatly mitigate the stern facts of the case! A sense of humor, alone, is sufficient to fortify a teacher in such a position; but, alas, much more than a sense of humor is needed to keep a teacher sane in face of the widespread abhorrence among civilized men for every kind of ordeal or test or trial of young men. No one would wish to go back to the practice of savages in dealing with young men, but the point of view of the softies is hopeless.

There is, of course, a very real constraint in the technical school. The unmistakable distress which grows out of this constraint is by no means confined to our less determined students and their over-indulgent parents, and the worst thing about it, as I know too well, is that it fosters an illusion of laborious study. I have known many students to fail because they could not, in their opinion, be expected to carry on in so strenuous an undertaking, and yet I have never known an engineering student, one not earning his own living, whose work was half as hard in fact as in his imagination or one-tenth as hard as the sympathetic members of his family thought it to be.

I am sure that my article on "Amelioration" in this issue of THE TECH ENGINEERING NEWS will only serve to strengthen a mistaken idea in the minds of some of your readers. Any one who likes to believe that the study of science is unredeemably dry and exacting will be encouraged in the belief; but every good sport will read between the lines.

The greatest fault in a person of serious purpose is to take himself too seriously; to think to himself of himself, "How virtuous am I; who do things with no fun in them." But nothing worth while is ever done except for fun! Be a good sport!

W. S. F.

A very small part of the distress among engineering students comes from the fact that a few of them are not at all adapted to mathematical studies. More than fifty per cent of those who enter our engineering schools drop out before graduation, and if this high mortality were due to essential non-adaptability, it would be a serious thing; but in the great majority of cases it is unqualified perversity, not mental deficiency, that is the cause of the mortality. But one should not use the word mortality in this connection, for many young men have been killed by being kept in college and no young man has ever yet been killed by being kicked out. Nor should one speak of unqualified perversity, for it is the God-given privilege of young men to go their own way. No, we should not speak of perversity but merely of unwillingness to study and think. Even so, it is life itself that must draw up their indictment; not one who knows the pains of those who really learn and the grief of those who are wise!

"All theory, my friend, is somber, gray;
And only the tree of life is green."

A great deal of distress among engineering students comes from the curtailment of normal instinctive activities which is inevitable when the energies of young men are largely devoted to serious study. Always, we must expect to find an undercurrent of melancholy among husky young men who cannot hunt and fish and play, and make love all of the time. What a wonderful field in which to make use of literature and poetry! For the fine arts, and especially literature and poetry, are useful because they alone can keep us moderns from reverting to outright savagery.

"Ernst ist das Leben, heiter ist die Kunst."

The older form of this saying is that life is short, short and somewhat empty; whereas art is long; but Goethe would have us understand that life is only serious and trying, whereas art is a flowing river of comfort and good cheer.

If I were a teacher of English in a technical school, I would expend most of my energies in a fine-arts emphasis on literature. However, technical education needs such amelioration no more than college education, for to deaden imaginative appreciation by over-much routine work is no worse than to let it be killed by sheer laziness. I would try to stimulate resourcefulness in recreation among my students. It is a popular belief that resourcefulness in recreation among college students is far above the dismal American average, but it is not so. Our college

(*Continued on page 152*)

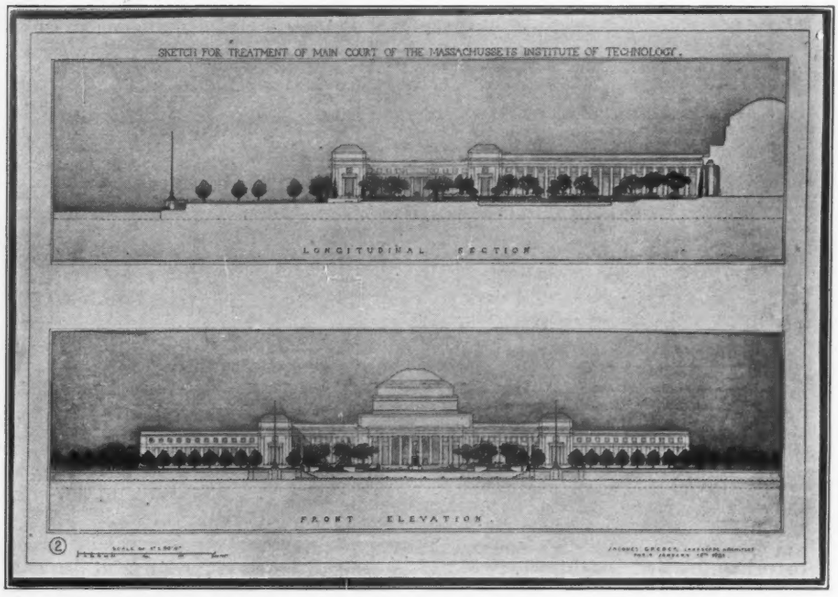
THE GROUNDS AND THEIR DEVELOPMENT

By H. J. CARLSON, '92

President of The Alumni Association, Massachusetts Institute of Technology; Architect, Coolidge & Carlson, Boston, Mass.

Approaching Technology from Boston, one is impressed by the setting of the parkway, the well-ordered river front, the palace scale of the buildings themselves, the great Court, and the superb entrance columns and dome, but a closer view shows us great dreary wastes of gravel, decrepit plank borders and wooden walks, with only here and there slight oases of green.

The architect shows us a layout for the general plan of the great Court, simple and dignified in treatment, with a rectangular pool in the center, flanked by paths, shrubbery, and trees that will effectually humanize this all too cold and cheerless place. If this is carried out, time will give us a quadrangle, handsomer than can be found in any other educational institution, and comparable to the Great Court of the Tuileries in Paris. But — thus far the tree planting has not been successful, and a careful study should be made of the earth and, possibly, the gases in it, the water level and its relation to the roots, the air and its pollution from city uses; then, after solving all these problems, trees that will survive such conditions should be planted with due care for roots and trimming, and with abundant watering and spraying until they have become accustomed to the new environment.


SKETCH FOR TREATMENT OF MAIN COURT OF THE MASSACHUSSETS INSTITUTE OF TECHNOLOGY.
LONGITUDINAL SECTION
FRONT ELEVATION.

ELEVATION OF THE PROPOSED TREATMENT OF THE MAIN COURT

It would seem that this planting should be for winter effect — that is — with stone pines, spruces, hemlocks, cedars, rhododendrons, and laurel, but relieved by such deciduous trees and shrubs as will give color and gayety to what would otherwise be too sober an effect and then, with two great flagstaffs rising out of solid green, the whole will be so habitable that the students will seek its shades as do the Romans the ilex terraces of the Villa Medici. The Great Court — now a gash, a rent that shows our poverty — would then be the jewel of our crown — gray walls, green foliage, blue waters and all, touched here and there by the brighter colors of those who use it. One of the most inspiring sights of Technology is the students at play in the late afternoon between Walker and the main group; if some of this activity and gayety could be transferred to the Great Court it would give intensive use to what is now a waste.

It is an axiom of college planning that Quad paths should be confined to pedestrians, but if it were possible to make an auto drive (not a parking space) up to the main entrance it would save what is now a weary walk from the Riverway to the Dome, and the space is so large that its opening to automobiles might well be considered. Speaking of easy access to the Dome, a dignified entrance could well be made from Massachusetts Avenue opposite the Dome, with possibly a small entrance court and planting at this point which, even at present, is the real entrance gate of the Institute; this would do away with the necessity for the Riverway drive.

Beyond this proposed Massachusetts Avenue entrance could be placed the great Auditorium that we are constantly needing with, let us say, seating for from five to ten thousand; with all stage facilities, with accommodations for dining, dancing, lectures, a place for Commencements, and a place to which we could invite *all* our friends and so bind them the more closely to us. Behind this Auditorium and behind the Dome, will come naturally the winged extension of the present plant. Here we may well pause and approve the wisdom of the planning of Technology, which, by its connected wings allows expansion or contraction of any department — something that is not possible in the separate buildings usually found in college planning.

Perhaps somewhere we may find room for a Graduate School. We have many college graduates who are now mixed with the regular students as an overload, possibly better results both for themselves and the undergraduates might be obtained if there were a separate graduate group; at least, this is worthy of consideration. Another group that might well be independent is a Research Department, and here we have the two divisions of pure research and our applied work that come directly from the "Technology Plan." Third, there is the Department of Architecture, now comfortably housed in old Rogers; some day, however, our beloved old home on Boylston Street will be sold; the well-known portico and steps will be no more and then — perhaps to the advantage of all — Architecture must cross the river to the main group. This Department would then be properly housed if placed on the Riverway between Walker and the main group. This, incidentally, will solve an architectural problem — that is, the proposed placing of small scale dormitories between the colossal buildings on either side.

Back of the Architectural Building, but still having good views of the Basin, would be the dormitories whose rear buildings might well rise higher than the main group — might even in one place continue up into a high residence campanile that would serve as a "pendant" for the Dome, just as at San Giorgio in Venice. Now, this may seem to be pushing the dormitories into the background, and at the risk of displeasing, I will go still further and say that while our first duty

is to technical education, our close second is to activities (and here I am thinking particularly of athletics) and our third is to housing.

Technology has about fifty per cent. of its students in activities, and such activities are essential if the graduate is to be a healthy, well balanced member of society; it is also essential that his "activities" be made as accessible as possible. If the play-field is a quarter of a mile away, it will not be used by a great number, while the dormitories can, if necessary, be at such a distance and still function properly. So, first, we should provide ample play space immediately adjacent to the class rooms, and this means in addition to fields, a real grandstand and a real gymnasium; then the space that is left may well be used for dormitories. Although I have said that our third duty was to housing, it is not my intention to minimize the importance of dormitories; they are, in a way, our greatest need. Many of us have seen the abominable boarding-houses that so many Tech men are forced to occupy with unwholesome surroundings, with companions not always elevating, and at best with distractions that harm the morale of the whole school; so our major problem is dormitories — dormitories — dormitories for all, at a price so reasonable that all would come.

All this of the Tech grounds and the buildings that should occupy them, cannot help but make us feel poor and calls to mind a remark that President Lowell made in his last report — "Universities, if successful, must be beggars, and the better work they do, the more they must beg." However, we need to remember, too, that here in America the real difficulty is not so much in getting money as in spending it wisely; not that things "just happen," for we must ask — and ask persistently (though tactfully), and then we may look forward with confidence to our quadrangle additions — though never to their completion, for there will always be something wanted for which we must keep up that necessary faith and hope that Bryce so perfectly describes in the closing paragraph of his "Modern Democracies"— "Without Faith nothing is accomplished, and Hope is the mainspring of Faith."

THE TECHNOLOGY SERIES

Loyalty to one's Alma Mater is primarily dependent upon a familiarity with one's Alma Mater and its buildings, surroundings, projects, and ideals. Unfortunately the great majority of Technology's Alumni have not had the opportunity of attending the new Institute and many have not even seen its new home. To remedy this situation as much as possible THE TECH ENGINEERING NEWS is publishing a series of nine articles on Technology as it is today. This article is the second of the series which as a whole includes

THE TECHNOLOGY BUILDINGS .....October
F. J. Whiting, Editor, Stone & Webster Journal.

THE GROUNDS AND THEIR DEVELOPMENT.....November
H. J. Carlson, President Alumni Association.

THE BUSINESS ADMINISTRATION OF THE INSTITUTE.....December
H. S. Ford, Bursar.

THE POWER SYSTEM OF THE INSTITUTE.....January
A. S. Smith, Superintendent of Buildings and Power.

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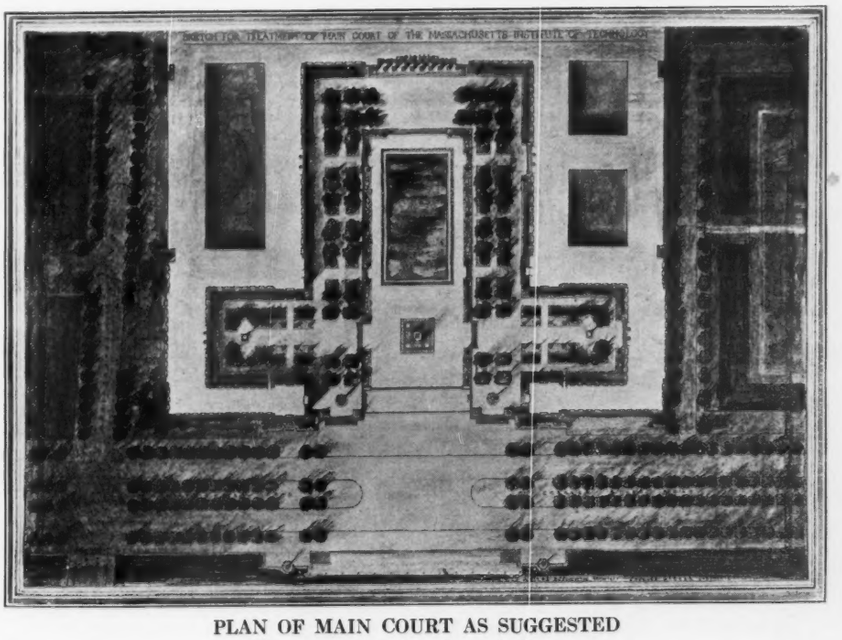
Prof. E. F. Miller, Head of Department of Mechanical Engineering.

THE MINING AND GEOLOGICAL LABORATORIES.....March
Prof. C. E. Locke, Associate Professor of Mining Engineering.

THE CHEMICAL AND PHYSICAL LABORATORIES.....April
Prof. H. P. Talbot, Dean, Former Head of Department of Chemistry.

RESEARCH AT THE INSTITUTE .....May
Prof. H. M. Goodwin, Professor of Electrochemistry.

PLANS FOR THE FUTURE...June
To be announced.



PLAN OF MAIN COURT AS SUGGESTED
The large pool will be the main feature.

INTERNATIONAL WIRELESS

Arrangements have been concluded by the Radio Corporation of America for the combining under one managing directorate a world-wide wireless system consisting of American, British, German, French and Argentine radio plants representing investments of $170,000,000.

The stations included in this system are the plant at Rocky Point, L. I., the British station of Caravon, Wales; the French Radio Universalle at Saint Assis, near Paris; the German station of Nauen and an Argentine station costing $16,000,000, which is nearing completion at Moote Grande, near Buenos Aires.

The Argentine station near Buenos Aires is claimed to be the most powerful radio station of the world and is described as covering 1400 acres with ten towers 800 feet high and a combined antennae length of seven and one-half miles of the station will operate with a wave length of 23,000 meters and have a range of approximately 10,000 miles, sufficient for direct communication with vessels and stations almost anywhere.

The receiving station of the Radio Corporation of America in New York will be headquarters of the international wireless system which will be managed by a directorate representative of all nations involved. Negotiations are being made to include in the system radio stations at Yokohama, Japan and Sidney, Australia. Test communications between New York and Buenos Aires will be made within thirty days and commercial service is expected to be established by May 1. This is supposedly the first direct radio communication between North and South America and will cut the cost of messages from 53 cents a word by cable to 28 cents a word by radio. It is estimated that the radio companies are handling 24 per cent of the total transatlantic communications. And the United States will gain many commercial advantages and general trade stimulation as a result of the arrangements.

INDIRECT CALORIMETRY AND ITS APPLICATIONS

By PROFESSOR H. M. SMITH
Professor of Inorganic Chemistry, Massachusetts Institute of Technology

Following the discovery of oxygen by Priestly, Lavoisier announced his theories of combustion in which he stated that "life is a chemical process." In his experiments he made measurements of the amounts of oxygen consumed by men at rest and at work and showed that increased work was accompanied with increased oxygen consumption, and he believed it was the oxidation of the tissues which resulted in the production of the body heat.

It is the food that we eat that keeps up the supply of the oxidative material in the body, and the sum total of the chemical changes involved with the production of heat is spoken of as metabolism. The degree of metabolism may be measured by the volume of oxygen consumed or of carbon dioxide produced, but it is more general to express the final results in terms of calories.

The amount of heat produced is dependent upon a variety of factors. It is evident that a large person will oxidize more material in a given time than will a small person, and also that a man at work will have a greater metabolism than when he is at rest.

The direct measurement of the heat evolved under various conditions was first accomplished by Atwater using a closed chamber known as a respiration calorimeter. In this chamber the subjects spent extended periods of time, and the carbon dioxide, water, and heat produced and the oxygen consumed were measured directly during the hours they were asleep, resting quietly or working vigorously. One such experiment showed, for instance, that out of a total of 5.136 calories, 4.593 calories were expended in body heat and 0.543 calories in mechanical work.

This method of measuring the heat production directly by the respiration calorimeter is elaborate and time consuming. In recent years great progress has been made in measuring the heat indirectly and so great has been this progress that it has practically displaced direct calorimetry in metabolism experiments.

Indirect calorimetry is based on the ratio of the volumes of the respiratory gases, and the known heat value of a liter of oxygen when it is consumed in burning pure food materials. If, for instance, pure carbohydrate is completely oxidized there will be formed the same volume of carbon dioxide as there is consumed of oxygen. The quotient obtained by dividing the volume of the carbon dioxide by that of the oxygen is called the respiratory quotient and in this instance it is one. If, on the other hand, pure fat is the material oxidized the respiratory quotient is 0.703, while that for protein is 0.80. From the combustion of these foodstuffs in a bomb calorimeter their heat values have been found to be approximately: protein, 4.1 calories per gram; carbohydrate, 4.1 calories per gram; fat, 9.3 calories per gram.

From these data the heat produced by one liter of oxygen when completely

DOUGLAS METHOD FOR COLLECTING THE RESPIRATORY GASES

consumed in the combustion of any of these foodstuffs and furnishing the above respiratory quotients may be found. For carbohydrates this amounts to 4.686 calories and for fat it is 5.047 calories, and for protein it is 4.485 calories. The metabolism within the body is usually that of all three of the above foodstuffs and the heat produced per liter of oxygen consumed will depend therefore upon the proportion in which these materials are present, and the character of this consumption will be shown by the respiratory quotient. Since the energy derived from the protein metabolized is not more than fifteen per cent of the total energy produced and since its respiratory quotient, 0.80, is approximately that for a normal person (0.82) living on a mixed diet, it is customary to neglect the protein as a separate source of energy and assume the respiratory quotient as being derived from fat and carbohydrate only. Thus a respiratory quotient of 0.85 might be assumed as furnished by 50 per cent of fat and 50 per cent of carbohydrate without introducing any serious error. On this basis Zuntz first calculated the heat values for a liter of oxygen for the respiratory quotients that might be obtained from the oxidation of different mixtures of fats and carbohydrates.

To determine the energy expended by a person by indirect calorimetry it is only necessary, therefore, to determine the volumes of the oxygen and carbon dioxide involved during a definite period of but a few minutes' duration. From the volume of the oxygen and carbon dioxide the respiratory quotient is obtained, and from the oxygen consumed and the heat value per liter as furnished by Zuntz's table the heat may be computed. For example, it was found that a person lying quietly consumed 229 c.c. of oxygen per minute, while the carbon dioxide produced was 193 c.c. The respiratory quotient was therefore 0.84. According to Zuntz a liter of oxygen consumed in burning fat and carbohydrate in such proportion as to give a respiratory quotient of 0.84 has a heat value of 4.85 calories. Therefore, the person was producing 4.85 times 229 divided by 1,000, equal to 1.11 calories per minute.

There are various ways by which the volumes of the respiratory gases may be found. In one system the subject breathes through a suitable mouth or nose piece into a circulating air current. This air is passed through weighed bottles of soda lime which removes the carbon dioxide and the increase in weight shows how much of this gas was produced. The oxygen consumption is determined by filling the system to its original volume with a measured amount of oxygen. Such a method requires a fixed apparatus and is not portable. This method has been especially developed by Professor Benedict of the Nutrition Laboratory of the Carnegie Institute.

A method devised by Professor Douglas of Oxford University employs a large rubber bag in which the exhaled air is collected by means of suitable valves attached to a mouthpiece or face mask. The total volume of the exhaled air is later measured and samples are withdrawn for analysis for carbon dioxide and oxygen. From the increase in the percentage of the carbon dioxide and the decrease in the percentage of the oxygen over that of the inspired air and the total pulmonary ventilation the volumes of the respiratory gases

are found. This method requires a delicate gas analysis apparatus.

The energy expended during exercise may be considered either in the light of total expenditure or as that portion of the total energy superimposed upon the energy required to maintain the body when at rest; that is, it may be regarded as a gross expenditure or as a net expenditure in accomplishing a definite piece of work. If the energy expenditures by different subjects at rest are to be compared there must be some common basis, and two units are in common use, a kilogram of body weight or a square meter of body surface. Results show that the normal man resting quietly expends about twenty-three calories per kilogram of body weight per twenty-four hours, or seven hundred and eighty calories per square meter of body surface per twenty-four hours.

Standing increases the body metabolism about twelve per cent above the lying values, while sitting quietly increases it five per cent. The metabolism of a person asleep is from twelve to fifteen per cent lower than when awake even though lying absolutely motionless.

In walking on a level the heat produced per kilogram of body weight is naturally dependent on the speed of walking. The increase in the energy requirement over that of the standing may vary from about one hundred per cent when walking at a rate of thirty to forty meters per minute to two hundred and seventy-five per cent when walking at the rate of ninety to one hundred meters a minute. The rate of increase appears to be uniform up to speeds of about eighty meters a minute; above this speed the rate of heat production increases in a greater ratio. If the heat production is figured per kilogram of body weight per horizontal meter moved, i.e. a horizontal kilogrammeter, the energy expenditure for different people amounts to approximately 0.5 gram calorie. This is practically independent of the speed for rates from forty to eighty meters per minute. Both above and below these limits the energy expenditure per horizontal kilogrammeter increases. It has been found that at speeds higher than eighty-five meters per minute it is more economical to run than to walk. Benedict and Murschhauser found that at a speed of one hundred and forty-four meters per minute the energy expenditure of walking over that of standing was 0.932 gram calorie per horizontal kilogrammeter, while for running the expenditure fell to 0.806 gram calorie.

If the type of work is such that it can be expressed in kilogrammeters, then comparisons may be made not only in terms of energy expended, but also in terms of efficiency, using the accepted values for the heat equivalent of a kilogrammeter.

In a series of experiments where walking at varying speeds was involved on grades ranging from 2.5 to 45 per cent, the efficiency was from 32.7 to 29.3 per cent when the amounts of work were from four hundred to sixteen hundred kilogrammeters. Greater efficiencies were found when smaller amounts of work were performed. When the subject was doing sixteen hundred kilogrammeters of work he was walking a forty per cent incline at a speed of sixty-five meters per minute, his oxygen consumption was at the rate of over 3,100 c.c. per minute and his carbon dioxide production was 3,000 c.c. and the heat was 15.65 calories per minute. This amounts to raising 156.5 grams of water from 0 degrees to boiling every minute. The experiments lasted eight minutes, at the end of which time the subject was "all in." It may be interesting to know that this amount of work could be accomplished on the energy supplied by a little less than fifty grams of white bread or an ordinary chocolate ice cream cone, or twenty peanuts.

In the above series of experiments the increase in the heat over the standing requirement increased regularly from 1.69 calories for one hundred kilogrammeters to 14.74 calories for sixteen hundred kilogrammeters of work. A definite amount of such work might be done by walking on a lower grade at a faster speed or on a higher grade at a slower speed. On this basis it was found that, although the differences were not great, there was evidence that for a given amount of work the subjects could accomplish it with a less expenditure of energy by taking a steeper grade at a slower speed. Perhaps this explains why the accustomed climber prefers to take a short and steep cut-off rather than the more gradual but longer path up the mountain.

The recent war emphasized the need of more information as to how the energy is expended by groups of men over the twenty-four hour day, and the efficiency with which they do their work, as well as the minimum food requirement which must be supplied for different kinds of work. In England, when the need of further reduction of the ration for the civilian as well as the recruit was pressing, studies were made by the Douglas bag method of the energy expenditures of soldiers during all their exercises from squad drill to bomb throwing and "digging in." Distributing the twenty-four hours of the day over the various forms of rest and activity the minimum ration of the British Tommy was computed.

In this country some work was done by the Nutrition Laboratory in which the metabolism of two groups of twelve men each was compared for a period of four months, during which time the ration was cut from over thirty-two hundred calories to nineteen hundred calories per day. Under these conditions the men lost twelve per cent of their weight. The evidence was that with the lower diet the men maintained their health and did their work, and since they had less weight to carry around there was a less consumption

(*Continued on page 154*)

Courtesy of the Nutrition Laboratory

APPARATUS FOR MEASURING THE ENERGY EXPENDED WHILE WALKING

THE ERECTION OF THE RADIO CENTRAL TOWERS

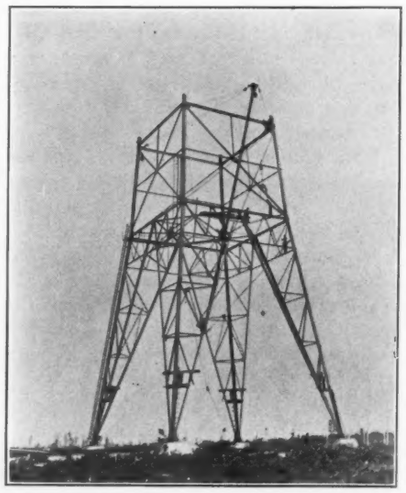
By DAVID S. FINE

Assistant Erecting Engineer, American Bridge Co., Philadelphia, Penn.

How an unusual and difficult problem in steel erection was solved through the use of ordinary and improved methods is well illustrated in the erection of the four hundred ten foot antenna towers with their one hundred fifty foot cross-arms for the gigantic New York Radio Station opened last November by the Radio Corporation of America.

The station occupies a site of ten square miles at Rocky Point, L. I., located about seventy miles from New York City. The station and its equipment are the last word in high power radio communication. It is the most powerful station so far constructed, and is planned to have finally seventy-two towers or twelve wings — each radiating from a central power house.

Twelve towers, forming two wings of six towers each, were erected. The towers are located in a clearing and are spaced about twelve hundred fifty feet apart, making length of each wing over a mile. The towers, which are self-supporting, are four hundred ten feet high, and are provided with cross-arms one hundred fifty feet long. Eight antenna wires are suspended from each side of the cross-arms. The lower two hundred fifty feet of tower was riveted and painted, while the remaining one hundred sixty feet including cross-arm was bolted and galvanized; this galvanizing eliminating frequent painting which would necessitate shut-downs to permit the painters to work in the high frequency zone near the antenna. The towers are four-legged or square in section, and have fabricated angles for diagonal bracing. The towers are provided with permanent steel ladders which extend from the ground to the cross-arms on outside of tower. The



RAISING FALLS OF THE FLOATING GIN POLE

weight of each tower is about one hundred thirty-five tons. The total tonnage in all the towers is sixteen hundred fifteen.

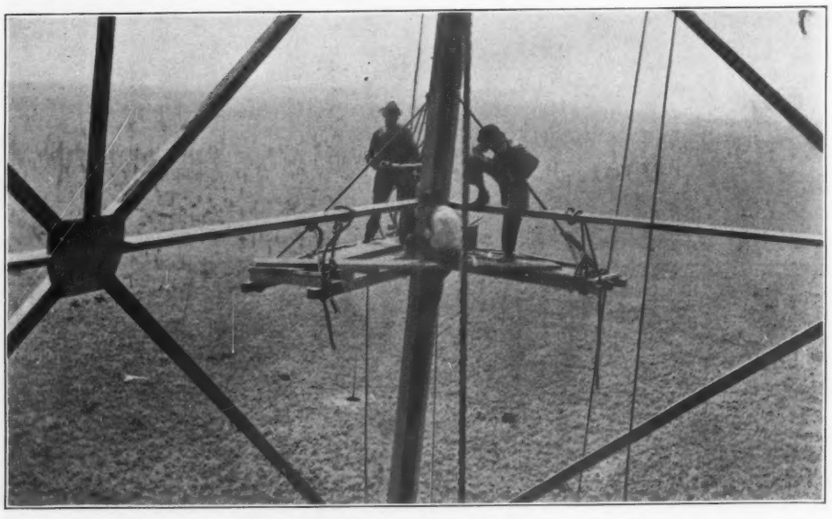
The delivering and storage yard was located about four miles from the central power house. Material was here handled by one steel stiff-leg derrick. The steel in the yard was not sorted into twelve towers, but all pieces of one kind were kept together. A road, newly built for the most part, ran from the yard and along the tower line with short tap roads leading directly to each tower. The steel was distributed to the various towers by a number of auto trucks of two and one-half tons to seven and one-half tons capacity.

The base of the tower is sixty feet square and seventy feet high, a height suitable for gin pole erection. An eighty foot gin pole composed of twenty foot sections of heavy ten-inch diameter gas pipe was used, the pole being raised to a vertical position by tripping with another short pole. The gin pole always worked inside of the tower and could be shifted to each corner of the tower or wherever desired. The four triangular corner sections of the base were each held until connected so as to be self-supported by one wire rope guy running back diagonally.

The body of the tower, composed of ten panels of thirty feet and one of forty feet, is thirty-eight feet square at the top of the base, and ten feet square at the top of the tower. It was erected with a floating gin pole, which is similar to the ordinary gin pole except that it is suspended in several sets of falls instead of resting on the ground, and is raised upwards as the erection proceeds. The floating pole was formed from the same eighty-foot gas pipe gin pole used in erecting the base by adding, to the foot of the pole, a steel saucer and fittings for the attachment of the four suspending falls.

The floating pole was rigged entirely with wire rope. It was suspended in four sets of falls composed of two parts of three-quarter inch rope, the leads of the falls running to the four spools of the hoisting engine. The top of the pole was guyed and controlled by four sets of falls composed of five parts of one-half inch rope, the lead of each falls running to a winch, one at each corner of the tower. The lower suspending falls were fastened to the tower by means of a wire rope sling wrapped around the tower leg and over the horizontal strut at a panel point, while the upper falls were fastened to the tower at the same point in a like manner with another sling wrapped around the tower leg but under the strut. The bottom of the pole was usually about thirty feet below the horizontal strut. The load line consisted of a single part of three-quarter inch wire rope, the lead running outside of the pole.

All steel for the body of the tower was hoisted outside of the tower. The pole would be leaned over, with-



RIVETING SCAFFOLD

The size of the trees in the background are indicative of the height of the tower.

out load, the proper amount, and the steel raised to place as it was out-hauled with manila rope tag lines. The horizontal level bracing which occurred at every other panel point was not erected until the foot of the pole passed that point, thus avoiding interference of the bracing with the pole.

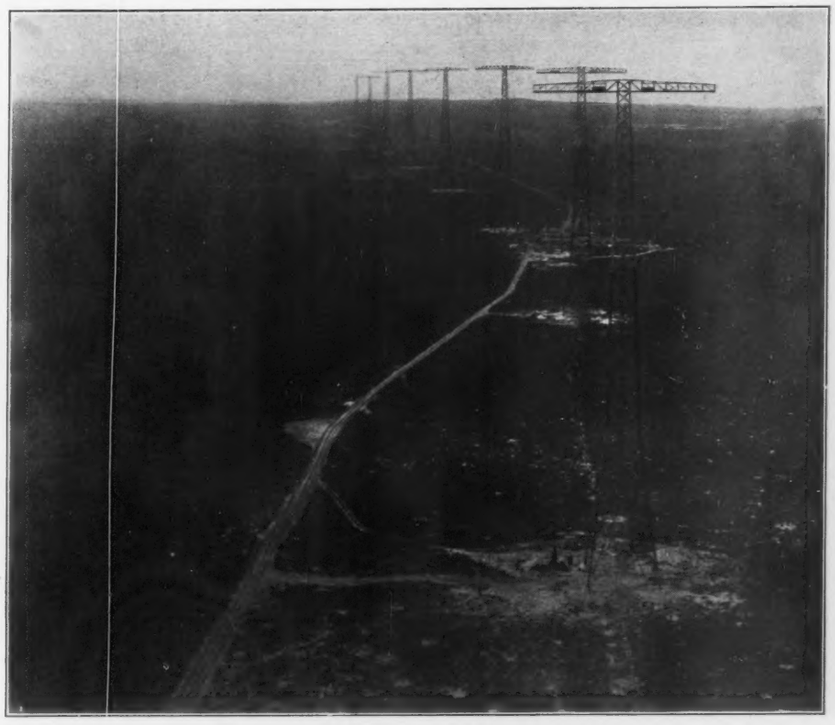
No elevator was provided for the men, they using the permanent ladder for climbing up the tower, the men being able to climb from the ground to the cross-arm in ten minutes. Signals were given by megaphone which proved more satisfactory than electric bell signaling.

After erecting a complete panel of tower the floating gin pole had to be raised vertically about a panel height, so as to be in a position to erect the next panel. To do this, the sheave blocks of the upper and lower falls themselves first had to be shifted to the panel point at the next higher horizontal strut. To accomplish this, the pole would be leaned well over to one corner of the tower and while three sets of upper falls held the top of pole, the block of the fourth or slack set of falls would be unfastened from the tower. The lead line of this falls would then be wound up on its winch, thus shortening the length of the falls and raising the block to the next panel point where it would be fastened to tower. Then the block of the lower falls at the same corner would be raised, but as this set of lower falls was necessary to carry the pole when in an inclined position, it had to be first temporarily replaced by a manila rope falls, after which the block of the lower falls was unfastened from the tower, and by means of the load line of the floating pole was then raised to the upper horizontal strut as the lead of the falls was let out and the lower falls lengthened. When this raising of the upper and lower falls was completed, the pole would be leaned over in the other corners and the operations repeated. The pole would then be placed in a vertical position, and raised upwards about thirty feet by shortening the lower falls through winding their leads on the spools of the engine, while the top guys would be let out. When the pole reached the desired height, the leads of the lower falls would be clamped to the spools. The average time required to shift falls and raise pole was fifty minutes.

The cross-arm is one hundred fifty feet out to out and is composed of two sections seventy feet long, connecting to the sides of the tower which itself forms ten feet of its length. The two half sections of cross-arm weighed eight tons each.

A rather unusual and difficult problem was presented in erecting the long cross-arm. While the cross-arm probably could be erected piece by piece by cantilever erection with a traveler working on each side of the tower, such method would be very costly and unsafe, particularly on account of the large number of small pieces composing it and the difficulty of making connections at a considerable height from the ground. An original and unique method, however, was used which permitted the complete assembling of the cross-arm in two sections on the ground and the raising of them bodily to the top of the tower — a method that proved very practical and economical.

The rigging used for raising the sections of the cross-arm was essentially a two-boom guy derrick, the floating gin pole serving as the mast. The booms were twelve by twelve timbers forty feet long, fitting into foot blocks resting on bearing plates fastened to two stringer timbers twelve feet long. These timbers in turn were fastened to two twelve by twelve timbers thirty feet long which were at right angles to the final position of the cross-arm and rested on the top of the tower which was ten feet square. The booms were held fixed in position and in line with each other by swing lines running to the ends of the thirty-foot cross timbers. The topping lift consisted of three parts of three-quarter inch wire rope and after the booms were set for the proper reach, the leads of the topping lifts were clamped to the spools. The floating ginpole, which acted as a mast, was suspended in the four lower falls and guyed at the top exactly as when erecting the body of the tower. The top of the pole, however, was in addition guyed by four spreader cables which passed over the ends of the thirty-foot cross timbers. The load falls consisted of three parts of three-quarter inch wire rope. The timbers and booms with their rigging were placed and dismantled with the floating pole. The pole projected about thirty feet above the top of the tower; the front reach of the booms was about thirty-six feet.



BIRD'S EYE VIEW OF RADIO CENTRAL
The power house is located back of the second tower.

Each section of cross-arm was completely assembled and bolted by hand on the ground on its side of the tower at right angles to its final position. To avoid throwing an eccentric load on the tower and to prevent excessive unbalanced stresses in the floating pole and rigging, it was necessary when raising the cross-arm on one side of the tower that the effect of its weight be counterbalanced on the other side of the tower. This balance was obtained by simultaneously picking both sections clear of the ground, thus throwing only a downward compressive force on the tower and equal loads on each boom. Then while maintaining this relation, the section of cross-arm on one side was raised to the top of the tower (as the other section hung in the load falls close to the ground), turned at right angles with the tag lines and connected to tower. Then while keeping the strain

(*Continued on page 154*)

TERMINAL SERVICE PROBLEMS

By J. ROWLAND BIBBINS

Manager, Department of Transportation and Communication, Chamber of Commerce of the United States

In order to gain a proper conception of the magnitude of the problem that confronts us the following figures may be helpful. At present, transportation is our second industry, with an investment (on a pre-war basis) of about $50,000,000,000, next to agriculture ($80,000,000,000) and exceeding manufactures, ($45,000,000,000). This is twice our national debt today and fifty times our pre-war debt. This vast sum is distributed approximately as follows: $20,000,000,000 in railroads, over $20,000,000,000 in highways and highway transport (excluding right-of-way), $5,000,000,000 in electric railways and the balance in shipping, waterways, and other services.

In order to provide a profitable return for these corporations the revenue would probably exceed $15,000,000,000 per year or over $140 per capita. From this it can be seen that the best results can only be secured when each service is working in its own proper field and cut-rate competition is not indulged in. It should also be borne in mind that Transportation covers the cost of the complete operation of moving goods in any form from seller to buyer. It includes collection, trans-shipment, and delivery, three items generally neglected.

Today rail transportation would encircle the earth one hundred and sixty times and would reach far beyond the moon if developed in a single line of track. Electric railways alone have a mileage approximately equal to the railroad mileage of the entire eastern district of the United States. About forty million people are largely dependent upon the electric lines for daily passenger transportation, and the electric railways come in contact with over ten times as many people as the railroads.

But the strangest aspect of this transportation development is that the electric railways costing about $3 per dollar of annual gross revenue, have confined themselves to passenger business alone, while steam railroads have reduced their cost to only $2.80 per dollar of revenue by developing both passenger and freight. Electric lines have had to be content with a rate probably under two cents per passenger mile as compared with a steam rate from two to three cents per mile, plus freight (both pre-war). On the steam railroads, freight revenue is normally three times passenger revenue; it is only a negligible fraction of the gross revenue of the electric railways. The steam lines are available for practically continuous traffic; the electric lines are used to only one-fourth of their investment and capacity, lying idle during most of the twenty-four hours. It is a fair question whether this situation is either sensible or economic.

It appears that, outside of main line mileage, steam railroads have perhaps half of their investments in terminals, sidings, yards and other trans-shipping facilities. For the terminals to be of most service they must be located in the center of the city where land values are high and consequently prevent future expansion. Could not the electric lines render valuable service here? Their tracks radiate and gridiron the entire areas of our cities and industrial centers in a manner entirely impossible for the steam lines. They have the same gauge and they intersect them at thousands of points. They reach every industry, very many of which are inaccessible to steam lines except through long trucking hauls from the freight terminals, as well as millions of retailers whose enormous tonnage likewise moves over the city streets.

Let us stop a moment and consider what actually passes over the streets of a modern city. In the United States 153,000,000 tons of farm produce is known to move over steam railroads. This amount is only the surplus over farm and local consumption. It is clear, I think, that perhaps more than half of the nation's domestic tonnage is transported over the public streets to the ultimate consumer, not only once but possibly several times. The best, quickest, most convenient and efficient way of transporting this tonnage is what is desired. In addition to this our streets must carry the enormous numbers (10,000,000) of passenger automobiles.

The Chicago vehicle registration, now over 100,000, has doubled in less than four years. Our city streets are fixed in width and can only be widened at prohibitive expense. It has been estimated that in our large active cities business will double in volume in from eight to thirteen years. How are we to take care of future developments?

Let us coördinate our facilities and use the electric railroads to distribute freight. They can do this at night when their plant is not used to its maximum capacity for passenger traffic. It will supplement their passenger revenue and serve to help them out of the effects of the war. They could take the freight from the steam roads and distribute it to outlying stations from which it could be trucked to its ultimate consumer. This would eliminate a large amount of motor trucking from the center of the city and would thereby save the streets of the municipality. There are so many cities in which long upgrade hauls to outlying sub-centers have to be made by every delivery vehicle starting from the big business center that it seems unbelievable that some such system has not been worked out before, on the score of better service and economy if for no other reason.

Naturally a new type of rolling stock would have to be developed. Possibly the compartment idea or the container system could be used. In this connection it should be noted that several railroads are already working on a plan of this kind.*

Closely allied to the problems that we have been considering are the terminal problems of the port. It may be noted in passing that the above plan would probably find its most useful application in a large port.

The port is regarded: first as a *reservoir* capable of absorbing varying volumes of traffic through it as affected both by long seasonal cycles and also the brief intervals between ship sailings; secondly as a funnel through which the commerce of the producing interior flows and is measured, inspected, and taxed, before proceeding on its journey to foreign destination; and thirdly as only one phase of the whole journey from inland producer to foreign consumer involving rail (or water) journey, port trans-shipment, ocean voyage, and port and rail movements abroad.

In the past more attention has been given to the development of the water side of the port than to the land side. The land side has generally been developed by the railroads with the result that there have grown up a great many highly individualistic solutions. The proper coöperation has been lacking and as a result terminal costs have increased at an extremely rapid rate.

Upon analysis of the business of a typical port it will be found that of the total car movement, only one-sixth is through land interchange, as

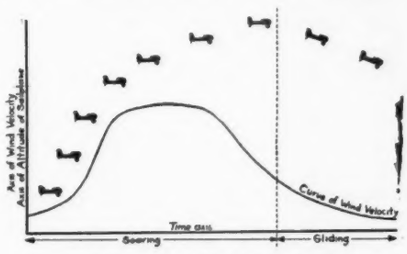
(Continued on page 162)

*See "The Growth of Highway Transportation," Tech Engineering News, June, 1922.

THE AMERICAN SAILPLANE

By FRANK M. GENTRY, '23
Massachusetts Institute of Technology

The recent achievements of the Germans in soaring flight from the summit of Wasserkuppe at Gersfeld where the student Hertzen remained aloft three hours and seven minutes in a motorless airplane, along with the Prémier Congrès Expérimental d'Aviation sans Moteur on Mount Combegrasse at Clermont-Ferrand, France, have created a sensation not only in aviation circles but among the public at large.



GRAPH OF MOTORLESS FLIGHT

The news dispatches from time to time have reported the participation of the American entry at the French meet; but little has been said concerning the details and construction of the little craft which journeyed abroad to represent the United States among the pioneers of motorless flight.

The American sailplane was financed, designed, constructed, and sent to Europe under the auspices of the Aëronautical Engineering Society of the Massachusetts Institute of Technology. The design submitted by E. T. Allen and O. C. Koppen was selected as the best among those received by the judges of the competition held for that purpose. After several modifications of the original plans, the machine was constructed and finally tested at Choate Island off Castle Neck, Mass., on June 12, 1922, where several successful flights were made. During the first half of the international meet at Clermont-Ferrand, under the skilled handling of Allen, it held first place until injured by a collision with spectators while taking off. The repaired machine was declared by the judges to be a new entrant and the previous records cancelled.

The M. I. T. soaring plane is built along conventional monoplane lines. The wing is of internally braced cantilever construction with a twenty-four foot span and a chord of four feet nine inches. The machine is about twelve feet long and weighs less than eighty pounds. The wing has a deep cross-section, seven inches at its maximum. The tips are tapered to a two-inch maximum depth. The wing is built in three sections for transportation but is quickly and securely fastened for flight. The ribs are unusually simple in design, yet they are remarkably strong. Under actual test, one of these ribs, weighing four and one-half ounces, withstood one hundred ninety-eight pounds distributed load. The internal bracing consists of light compression members, steel wires, and cotton tape. There are two wing spars built hollow with ply-wood sides and spruce cap-strips. The covering is a light mercerized cotton such as is often used for the envelope of balloons. It was given two coats of dope to draw it taut. There are one hundred twenty square feet of supporting surface. The wing has no dihedral angle.

Adding to its long list of honors and keeping up to its reputation in engineering matters, Massachusetts Institute of Technology was brought to the fore again by the success of the sailplane designed and built by the Aeronautical Engineering Society and taken to Europe by E. T. Allen, O. C. Koppen, and H C. Karcher to participate in the International Glider Contest at Clermont-Ferrand, France. The first plane, a picture of which appears in the following article, was overtaken by misfortune early in the contest, but its three operators showed every one the real "Tech Spirit" by having another machine built in two weeks.

Not only are these achievements of interest to Tech men, but the reputation of our country has been saved by the appearance of at least one entry from this side in these very important trials.

Massachusetts Institute of Technology has not only been well advertised by this achievement, but its already high prestige has been enhanced. — Editor.

The fuselage of the M. I. T. model No. 1 was rectangular in cross-section and not streamlined. The pilot's seat was below the wing. In the M. I. T. model No. 2 the fuselage has a circular cross-section and is carefully streamlined. In the later model, the pilot's seat is raised so that his head protrudes above the wing through the cockpit.

Both models are provided with the usual control surfaces. In the first model the ailerons extend only the length of the end sections while in the second model they extend the whole length of the wing. The remaining surfaces are somewhat larger in the later machine than in the earlier sailplane. The skids used for a landing device on the M. I. T. model No. 1 were afterwards substituted for light wheels.

It requires at least a wind of about fifteen miles per hour for any success at motorless flight beyond simple gliding from an elevation to a lower level. In taking off a catapult arrangement is employed. A rope is hooked to the nose of the machine which faces head-on into the wind. Two men then pull the rope and launch the sailplane into the air where the pilot becomes dependent upon the air currents and his own resourcefulness to sustain himself.

Air-yachting is distinct from gliding just as sailplanes are distinct from gliders. Almost any contrivance carrying an aerofoil and properly balanced will glide. It amounts to nothing more than sliding toboggan-fashion on the air from one height to another. But to soar requires first, a carefully designed machine with low resistance and high lift coefficients, second, delicate control and maneuverability, and,

(Continued on page 160)

AMERICAN SAILPLANE NUMBER 1

This is the machine that crashed after making some exceptional records.

DR. SAMUEL WESLEY STRATTON

By GEORGE K. BURGESS, '96

Physicist and Chief of Division of Metallurgy, National Bureau of Standards, Washington, D. C.

While attending the Standardization Conference of the Mining Congress, I read, in the Cleveland paper of October 12, of the selection of Doctor Stratton as President of Technology. I immediately wired him as follows: "Congratulate Technology on securing you for leader." Every alumnus of the Massachusetts Institute of Technology who knows Doctor Stratton feels, I am sure, that a better choice could not have been made and that Technology is to be congratulated.

You who are not yet well acquainted with him ask one who has had the privilege of daily association with him for twenty years what manner of man it is who has been elected to the Presidency.

Born and reared in the Middle West, where he also spent twelve years as University Professor, coming to the Bureau of Standards from the University of Chicago where he had headed electrical engineering, Doctor Stratton is a man of no sectional prejudices. He has probably as wide an acquaintance among men of science, industry, engineering and business as any single American. At this time and place it is possible to mention only in bare outline his accomplishments in science, standardization, education, organization, and administration.

Doctor Stratton is a man sixty-one years young; he has the wisdom of his years, the activity of a man of forty and the enthusiasm of a youth of twenty. His most preëminent characteristic is that of a leader of men; this is coupled with an unusual intuitive ability to take the measure of a man on sight. Once his confidence is placed in a man it remains through thick and thin. Placed for twenty-one years in a position of almost absolute authority over a growing government institution, the Bureau of Standards, he has developed none of the characteristics of the "bureaucrat"; and such has been the confidence in his leadership that he has been able to retain about him, practically intact, except as death has called them, the original group he selected as his associates. He never gives orders, and insists he does not want associates to whom the giving of orders is necessary, and he abhors rules and regulations. He hates a fight, but once engaged he is the hardest fighter I know; and when he has won, he promptly forgets the controversy and harbors no resentment against the adversary.

Conversely, he is restive under restraint and dearly loves his own liberty of action. I vividly recall an instance, now years past, of a project for which I very much wanted a favorable decision, and consequently prepared the case so there was no logical escape from what I thought would be the inevitable "yes." Doctor Stratton listened to my presentation, read my brief and then leaned back and brought his fist down upon the desk, saying, "Burgess, I will not be made a rubber stamp."

Another trait which will be of outstanding importance for the Institute is his genius in organizing experimental research, accompanied by a farseeing vision of what problems to attack and when to press their urgency and opportuneness upon those providing the funds for their support. Always interested in the new things of science and engineering, after an investigation has been planned in broad outline and turned over to one of the Division Chiefs of the Bureau, he never interferes in the execution of the work, but puts the responsibility for results squarely up to the man in immediate charge. This policy of non-interference with what they consider their work, accounts, perhaps more than anything else, for the loyal support he has always received from his associates. Strictly impartial and always glad to see credit given to whomever due, he encourages every man to become a specialist or expert in some one line. In his annual talks to the scientific staff he always stresses the opportunity of the youngest or least experienced member of the staff to become a leader in his chosen field.

It has often been justly said that Doctor Stratton has been remarkably successful in securing the support of Congress in the development of the Bureau of Standards. The secret of this success is threefold: he has had the foresight to choose the right moment for presenting a given project which would appeal to Congress, he usually has had the backing of others who knew the situation, and he always told the truth in a forceful and convincing way.

His interest in the welfare and advancement of young men has always been very keen, and for the Bureau he persuaded Congress to approve a system of apprentices in both technical and clerical services, by which an ambitious young man who has not the means to go to college may be advanced through the grades in the service and get his college education at the same time. To stimulate graduate study he established at the Bureau what is, in effect, one of the best Graduate Schools in Science in the country.

The half hundred or so Ph.D's resulting from this policy have, of course, not been awarded by the Bureau, but are scattered throughout the universities of the country. The Bureau is an ideal place to work up an experimental thesis and individual arrangements are made with universities for the doctorate. It is, perhaps of some interest to note, that the graduate courses given at the Bureau—often registering above two hundred students — are arranged by a joint Committee of Students and senior members of the staff, the student members being chosen by the student body. The "professors" are chosen annually from either outside or within the Bureau to fit the courses wanted. This again tends to render more content scientific men in Washington who are not happy unless teaching — and there are many such men.

The first year of the Bureau's establishment, there were instituted weekly meetings of the scientific staff for the presentation and discussion of their investigations. These meetings have been greatly extended in scope and include volunteer, topical lecture courses in addition to the regular courses of instruction. Each division of the Bureau, as electricity or metallurgy, has also its own professional meetings.

Those of you who are familiar with the "Technology Plan" of industrial research, will be interested in the practice recently and tentatively inaugurated at the Bureau of Standards by Doctor Stratton, primarily as a device in self-defence to prevent too rapid depletion of the staff by industrial interests. Under this scheme an industry sends men to the Bureau for work on problems of interest to the industry and coming within the field of the Bureau's activities. After a year or two these men renew their industrial connection, taking back to their industry a knowledge of our methods of work. This plan gives promise of being of great usefulness.

During his twenty-one years in Washington, although his main work has been administering and developing the Bureau of Standards, his activities have by no means been con-

fined to this. His advice and services have been sought more and more on questions and projects of general administrative interest, and he is usually found on most important departmental and inter-departmental committees. To mention but two instances, his membership on the Advisory Committee for Aeronautics has kept him not only in closest touch with, but also in responsible charge with others of, all government work relating to research in aviation. Again, he is chairman of the recently established Federal Specifications Board charged with the important and never before tried task of unifying all government specifications for purchases of supplies; and when you appreciate that the government is the largest buyer in the country of the most diversified list of commodities, you may perhaps form some conception of the complexity, importance and magnitude of this endeavor.

If you were to ask what is Doctor Stratton's hobby, I should answer without hesitancy, farming. During a large part of each year he has been able to take week-ends down on a farm on Chesapeake Bay, and there refresh his strength for the strenuous life of a director of a great bureau. He has encouraged the cultivation of farm and garden plots by members of the staff on land adjacent to the Bureau, and many have taken advantage of this opportunity.

An account of what Doctor Stratton stands for would be incomplete without reference to his social activities. The great event of the year is "Doctor Stratton's Garden Party" for the children. The Bureau has a formally organized entertainment committee, and social gatherings at the Bureau are encouraged; these are of many forms, from receptions and dances to lectures and musicales. These things may sound natural enough to a Technology man, but they were unheard of at a government bureau before Doctor Stratton's time. He is always starting something new and worth while.

When Mr. Freeman in a recent number of the *Technology Review* stated the specifications for a college president, "but after all, is not the foremost and greatest requirement for a college president that rare gift of being able to lead the thought of young men; ability to kindle the divine fire in young and courageous hearts, like that possessed by President Roosevelt, or the famous Doctor Arnold of Rugby, or our own lamented Sedgwick. A quality of equal importance, because of the few points of direct contact between president and student, is that rare but most important gift of personality which can arouse and encourage coöperation and enthusiasm and industry for these same ends throughout the scattered, broad and diverse members of a college faculty," he must have had Doctor Stratton in mind.

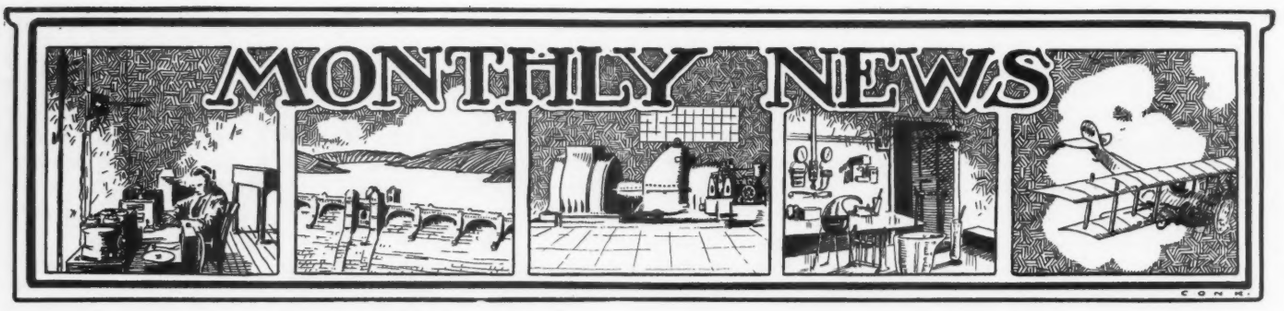
Doctor Stratton will bring to Technology the prestige of a remarkably successful man; a man who has always held the esteem and confidence of his associates and of the public; a man who believes in his fellow-men and who understands the aspirations of youth; one who in the best sense of the word is an optimist and whose watchword has always been "coöperation"; a man of widely diversified intellectual interests and of extraordinary executive ability. I believe he will be a worthy successor to our founder, President Rogers.

DR. SAMUEL WESLEY STRATTON

Comment by the *Boston Transcript* on Dr. Stratton

Election of Dr. Samuel W. Stratton, director of the Bureau of Standards, to the presidency of Massachusetts Institute of Technology has greatly stimulated popular interest in the achievements of the Bureau, of which he has been the creator and sole directing head since its organization. The severance by Doctor Stratton of his relations with this great institution is indeed, as Secretary of Commerce Hoover has said, "a national loss," yet some compensation may be found if even temporarily public attention is directed to some details of the work he leaves behind him.

Dr. Stratton diplomatically hesitates to discuss his plans with reference to his conduct of the Massachusetts Institute of Technology, partly out of courtesy to the trustees whom, of course, he must consult concerning them. But it is violating no confidence to say that the new president, through his experience here, will be able to develop a closer relation between the Institute and industry than ever has been established before and that he will seek to introduce new lines of work and of experiment which can be conducted as advantageously by the Massachusetts Institute of Technology as by the Bureau of Standards. One, indeed, needs only to read the last annual report of the Director, in which the activities of the Bureau are very clearly set forth, to infer that many lines of work there described will be duplicated in Cambridge.



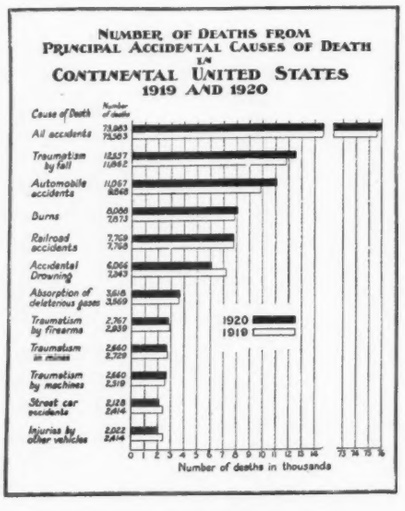
Safety First. Seventy-six thousand accidental deaths — a life needlessly snuffed out every six minutes — is the astounding bill charged against careless America during 1920, according to the report of the public accident statistics committee of the National Safety Council presented at the Eleventh Annual Safety Congress which was held August 28 to September 1.

While the 1920 toll from all public and industrial accidents — representing the total population of the state of Nevada — is a decrease of 3,300 over 1911, the beginning of the decade, there is only a balance of 400 on the credit side of the ledger over the 1919 total. This record is viewed with concern by the nation's leaders of organized accident prevention since the yearly downward tendency of accidental deaths in the United States during the past decade, constant up to 1919, came to a halt in 1920.

Automobile accidents are held to be in part responsible for the unfavorable experience of 1920; in that year there were 1,200 more deaths from that cause than occurred in 1919. The chief reason for this, it is pointed out, was the large increase in the number of automobile users. The automobile fatality frequency for 1920 was 30 deaths a day, a total for the year of 11,000. The 1921 estimate of automobile deaths, based on figures now available from 50 of the largest cities, indicates a considerable increase over 1920. General traffic accidents in 1921, however, will show a 5 per cent decrease over 1920, it is believed.

People died from falling accidents of all kinds at the rate of 34 a day, a higher rate than even automobiles. Burns claimed 22 lives a day, a total for the year of 8,088 and an increase of 215 over 1919. Other major causes of accidental deaths are listed in order of importance as follows: Railroad accidents, 7,769; drownings, 6,066; deaths from gasing, 3,618; firearms, 2,767; mine accidents, 2,660; machinery, 2,660; street cars, 2,128; other vehicles, 2,022; conflagrations, 1,277. Other general causes of deaths are crushing accidents, poisonings, sharp instruments, excessive heat or cold, injuries by animals, lightning, and electricity.

Accidents in industry show a general decline of 1.3 deaths per 100,000 population for each year of the ten-year period while public accidents decreased 1.1 per 100,000. The 1920 report shows public accidents on a slight upward turn while industrial accidents declined, this in spite of increased manufacturing activities. This is said to be due to the aggressive spirit shown by industry as a whole in organizing for safer working conditions. Total industrial fatalities in 1920 were set at 12,500. The 1921 total, so far as can be anticipated


NUMBER OF DEATHS FROM PRINCIPAL ACCIDENTAL CAUSES OF DEATH IN CONTINENTAL UNITED STATES 1919 AND 1920
Cause of Death
Number of deaths
All accidents 73,063 75,563
Traumatism by fall 10,657 11,845
Automobile accidents 11,057 8,048
Burns 8,088 7,873
Railroad accidents 7,769 7,769
Accidental Drowning 6,066 7,243
Absorption of deleterious gases 3,618 3,569
Traumatism by firearms 2,767 2,839
Traumatism in mines 2,660 2,729
Traumatism by machines 2,660 2,519
Street car accidents 2,128 2,414
Injuries by other vehicles 2,022 2,414
1920
1919
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Number of deaths in thousands

from figures collected from insurance companies and other agencies, will probably be still lower because of the falling off in employment.

Chief causes of industrial fatalities during the period from 1912 to 1920, as shown by figures collected by the industrial department of the Metropolitan Life Insurance Company are railroad accidents, falls of persons, machinery accidents, mines and quarries, electricity, drownings, street cars, automobile accidents, burns, and gasings, listed in order of importance.

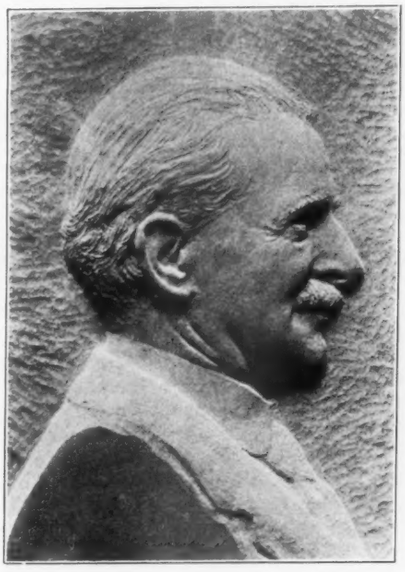
Crude Oil Motor. A new French motor recently completed a thousand kilometer trip burning crude oil throughout the journey and carrying five passengers at an average speed of forty-eight kilometers per hour. The motor is built to use gasoline, crude oil, kerosene or vegetable oil interchangeably and is supposedly the first of its kind to operate with any marked degree of success. An average of sixteen litres of oil per 100 kilometers was consumed. The cost of fuel at current prices of 34 centimes per litre was approximately 59 francs for a trip of a thousand miles.

Sculpture by Camera. Due to the efforts of Mr. Howard M. Edmonds, a Massachusetts Institute of Technology graduate of the class of 1905, portrait sculpture is now possible by the aid of photography. A person may desire to have his portrait preserved for future generations not by the photographic process but in imperishable marble. Previously this meant a series of tiresome sittings for the one desiring the sculpture, great art on the part of the sculptor and great patience on the part of the sitter. The skill of the sculptor was slowly acquired, dearly bought and dearly to be paid for, but today mechanical skill reproduces an exact sculptural likeness in the same manner as a photograph and at a cost to suit the pocket of many.

The process is no more tiresome to the subject than that of getting one's picture taken. All that is necessary is to sit in front of an especially arranged camera, hear the shutter click and the thing is done as far as the sitter is concerned. A few days later your exact likeness will be handed you in imperishable marble or what not. It is accomplished as follows. A lantern projector, popularly known as the magic lantern, throws on the face of the sitter a series of closely set lines. These lines projected on a screen are fine straight parallel lines but as thrown on the face of the subject and as viewed from a certain angle appear curved and follow the contours of the face.

The lines are so closely set that every contour of the face shows and the more rounded the features the more curved the lines. A photograph is then taken of the subject with these lines projected on the face with a

strong light and the negative shows the many curved lines on the face. A positive is then made from the negative and given to the operator of the carving or sculptoring machine. The photograph and also the marble or such material as may be chosen by the model is placed in the machine. Connected with the machine is a drill which can be made to rotate and also to move in a straight line and scratch thin lines on the marble. The operator, by the use of levers and handles, can control the drill and make it begin and end at any point and can regulate the depth of cut. To secure a likeness of the model the operator manipulates a pointer which is connected to the



A BAS-RELIEF MADE BY THE PHOTOGRAPHIC PROCESS

drill so as to follow the curved lines on the photograph. As the pointer traces out the lines on the photograph the drill moves up and down making various depth cuts as it moves along in its straight line path. As the lines curve in on the photograph the drill cuts deeper and as the lines curve out the drill cuts shallower and in this way the varying contours of the subject's face are reproduced in marble. The finished product is in relief exactly as the portrait on the photographic plate and it is found in practice that polishing and a certain amount of hand-carving of the hair is necessary, but otherwise the machine does the entire work of carving and, by eliminating the necessity of a skilled sculptor, brings the sculptored portrait within the province of persons of moderate means.

It is expected that an article by Mr. Edmonds concerning his invention will be published in a later issue.

BOOK REVIEWS

Van Nostrand's Chemical Annual, edited by J. C. Olsen. New York: D. Van Nostrand Co. 1922. Fifth issue. 5×7¼, xxii+900 pp. $4.00.

The editor says in his preface to the fifth issue of this Annual that after a careful search for new and useful tables about forty-six have been added. These include tables of ionization of acids and bases, new specific gravity tables, and new vapor tension tables. A considerable number of compounds have been added to the table of inorganic compounds. In toto the Annual presents compactly more useful material than any of the various other chemists' handbooks which have wandered into our hands.

Machinists' and Draftsmen's Handbook by Peder Lobben. New York: D. Van Nostrand Co. 1922. 4½×7½, 487 pp. $3.00.

There are handbooks and handbooks, yea, and more handbooks. We're swamped with 'em at an institution like Technology. This is Mr. Lobben's third edition, to which he prefaces the remarks that he has "taken the opportunity of correcting some minor errors and revising a few of the tables in the steam section, as well as to make the electrical formulas conform to the new standardization rules." The book is well worth a third edition; we only wish that we had met it earlier in our scholastic career, so that we might have had the benefit of the explanations and expositions accompanying its rules, and had not been compelled to get along with manuals giving very elaborate (and no doubt very useful) formulæ, but failing completely to give a hint of the method of their application or an explanation of their derivation.

Mr. Lobben has made this more than a handbook; it is a veritable dictionary. He begins the invariable "Notes on Mathematics," and subsequent thereto has separate divisions for "Arithmetic," "Algebra," "Logarithms," "Geometry," and "Mensuration" (all of which we thought were branches of Mathematics, but we defer to high authority). Thereafter we find a comprehensive collection of tables, and formulæ, plus the usual explanations, for "Strength of Materials," "Mechanics," "Power Transmission," "Gears," "Screws," and "Pipes." Then come some few pages of notes of hydraulics, steam, and electricity, a medley of miscellaneous "Shop Notes" and three final paragraphs on "Blue Printing."

Truly, if a man desires more he'd better hire a bibliographist and tackle the Central Library.

Mechanical Laboratory Methods of Testing Machines and Instruments by Julian C. Smallwood, M. E. New York: D. Van Nostrand Co. 5×7½, xiv+423 pp. $3.50.

A text book for the use of students in mechanical engineering laboratories is usually either a hard and fast set of rules, applicable to the apparatus and procedure of a given institution, or else a treatise on experimental engineering. In the first case the result is a book useful only to the students of a single school, and becomes inadequate, even for them, as fast as changes in equipment or method are made. In the other case an effort to be complete produces such a large amount of material that the book becomes unwieldy. Professor Smallwood has avoided both of these extremes in the preparation of his manual, and has produced a readable, easily usable book which will apply to any course in testing power plant apparatus. At the same time it should prove a convenient aid to the engineer in commercial testing.

A brief outline of the principle of measurements and their accuracy is given in the introduction. This is very valuable in guiding to a middle path between the refinements necessary in a physics laboratory and the unintelligent guess as to accuracy which sometimes characterizes so-called engineering experimental work.

The first division of the main body of the text covers the principles and testing, or calibration, of instruments. Considerable space is given to the engine indicator, showing methods of calibrating springs, drum motions and reducing motions. A valuable item is a brief section on averaging circular charts.

The Analysis of Combustion is the title of the second part, which deals with methods of determining the constituents of fuels and of the products of combustion. The use of these data in solving the problems of combustion is outlined.

Part three covers the testing of power plant units, including steam and gas with their auxiliaries, air compressors and fans and refrigerating machinery. The requirements of the American Society of Mechanical Engineers' Power Test Codes are followed, although the actual codes are not given. The directions and explanations in the text are much more simple and clear than those in the formal codes.

An appendix contains a collection of convenient tables and some material on hygrometry.

The present Third Edition, the section on Combustion, has been rewritten and simplified, and a second appendix added which contains the proposed American Society of Mechanical Engineers' Code of Definitions and Values.

DeWitt M. Taylor.

A PRESIDENT

Technology has once more a President. There are but comparatively few undergraduate students at the Institute today who have known Technology with a president; for nearly a whole collegiate generation has passed since the man, to whose vision and perseverance we owe the New Technology, was taken away. During that time, Technology students have no doubt missed a great deal, for, save a few brief months, there has been no president, even in name. And with no directing genius, Technology has had no opportunity to be all that it might.

THE TECH ENGINEERING NEWS congratulates Doctor Stratton and welcomes him to Technology. Here is a man for whom it was indeed worth while waiting. An eminent scientist and organizer, he has made the Bureau of Standards the important influence that it is today. In Washington the two names are almost synonymous.

He comes to Technology when its development in its new home is still in its infancy. The successful use of the tools Dr. Maclaurin gained lies in the future. The briefest glance at Doctor Stratton's record in the past gives ample assurance that his work at Technology will reflect credit and distinction on both himself and the school.

Again, welcome and best wishes.

AN M. I. T. REGIMENT

The Department of Military Science at the Institute has attempted a broadening of its organization, both with regard to the men taking the required military science courses, that is, the Freshmen and Sophomores, and to the advanced students, which has abundant promise of becoming both an interesting and influential part of Institute life.

The suggestion for this extended organization came from several of the Reserve Officers' Training Corps students themselves, who felt that a more unified organization of the military science students at the Institute would greatly increase the benefit to be derived, both from the basic and the advanced courses; would create a certain *esprit de corps* among the men taking these courses; would make the advanced R. O. T. C. work more attractive to basic course students; and would make the work of the whole Military Science Department more effective and beneficial. The Department had been timid about proposing such a broadening itself, for it felt that the average Tech man is already so busy that its making the military work any more rigorous, even though the increase be very slight, might be placing such a burden on the man that the result might be an entire breaking away from the advanced work, and thus a defeat of its purpose. When, however, the suggestion came from the students themselves, the Department was delighted to assist in drawing up definite plans and in setting them in operation. The scheme has everywhere met with the approval of the men most intimately concerned, and certainly appears worthy of the support of every man truly interested in Tech affairs; for it offers promise of making the military science work at the Institute something more than an object of good-natured ridicule which circumstances have, in the past, forced it to be to a very appreciable extent.

Briefly, the plan of organization is as follows. A regiment, to be called the Massachusetts Institute of Technology Regiment, has been formed. Every student of Military Science at Technology, whether basic or advanced, has a definite place in this regimental organization. The cadet officers are to be chosen by the Department from among the advanced students. They will be chosen from their records as regards military work at school and at their summer camp. Commissions as cadet officers will be offered these men, who may accept them or not, at their own option. Acceptance does, however, carry with it the obligation to assist in drilling the Freshmen or in instructing in the advanced courses for one hour each week. Obviously, this is not an exorbitant requirement. And the benefit the man derives from this work, provided he can spare the time for it, should be more than commensurate with the extra effort expended.

This drilling and instructing by the cadet officers will be perhaps the most important innovation brought about by this plan.

By a fortunate coincidence it had, last spring, been decided to require the advanced students to wear uniforms at their recitations. Although, as this is written, these uniforms have not yet made their appearance upon the campus, and hence no judgment of their appearance can be made, by the time this is printed that judgment will have been passed; and it seems not too much to hope or expect that it will be favorable. In any event, the cadet officers will be able to perform their duties attired in a distinct type of uniform which will set them apart from the Freshmen and thus add a certain status and dignity to their position.

The benefits to the advanced students, to the basic students, and to the Department itself are numerous. This plan should help the Department by making its work more interesting, by giving the basic students an additional incentive for continuing with the R. O. T. C. work, and by giving the advanced students an incentive to do their work better. If it had no other effect than to attract more men to the advanced work it would have already justified its existence; for in these days of our rapidly decreasing army, the nation must come more and more to rely upon trained reserves for an emergency. And the very best reserves are those trained in these R. O. T. C. units.

For the basic course men this organization should be of advantage in getting them interested in the work in showing them that there is a great deal more to it than just a course which they must pass.

For the advanced students, and especially those who are officers, there is much of interest. Here is an opportunity for the future Reserve Officer to become familiar with all those details of military life and custom that he would need in actual service, but which he has too little opportunity to learn and appreciate. He can also learn to command men, to become accustomed to handling men and situations. And in the ultimate analy-

sis, that is perhaps the most difficult of life's problems — to handle men; and whatever he may learn about it on the drill ground will certainly stand him in good stead in later years.

There will no doubt be scoffers and deriders of this scheme. There will be those who will refuse to take it seriously, who will consider the R. O. T. C. uniforms objects of good-natured ridicule. Now, the success of this plan lies in its being taken seriously; and the men who have the best interests of the Military Science Department, and thus of the Institute, at heart, cannot be too strongly urged to give it their undivided support, regardless of what opposition they may encounter.

RECREATION

No matter how deeply absorbed we are in our work, or how anxious we are to drive on to results and achievements, there come times when we feel the need of recreation. Some people feel, or think they feel, the need of it much more than others do; but even those people who are intensely interested in their work and who can, by their will power, drive themselves on, cannot fail to appreciate the great benefit to be obtained from getting away from their job and completely forgetting it for a time. It is a familiar fact that when we have been struggling with some problem, and can seem to make no headway, a change of thought or occupation for a time will send us back to the problem refreshed and encouraged. That recreation is not only a valuable but even an essential part of the most efficient life is hardly disputable.

But the means of obtaining our recreation is of as great importance as the recreation itself. Samuel M. Vauclain, president of the Baldwin Locomotive Works, makes this interesting remark in the course of an article of which he was the author and which recently appeared in *Collier's*. "Whenever I feel the need of recreation I just change my work — go out and bring in some orders for locomotives — or something of the sort." Here is an idea that no doubt a great many of our more successful men find valuable, for, after all, the change is the thing that makes recreation valuable. There seems no very valid reason why every one could not make his moments of recreation valuable.

To be sure, there are many who will protest that a mere change of the kind of work is not true recreation. That may be quite true if one's interest is not in one's work. It is probably true that for the great majority of people a change of work for recreative purposes is neither possible, feasible, nor satisfactory. There still remains the possibility of making of their recreative moments something more lasting than the mere passing joy or contentment of thoughtless loafing or playing.

For example, if one is fond of books, there is no reason why one's reading should not be systematic and thoughtful. Careless and thoughtless reading for mere pastime is commonly credited with being one of the major causes of poor memory. Or if one is fond of music, a study of the history and theory of music should prove not only excellent recreation but a valuable aid in appreciation of music. There are innumerable other suggestions of this same kind. Recreation of this type can be enjoyed daily and, if thoroughly and sincerely practiced, can be of immense cultural as well as recreational value.

For those recreational periods which are of somewhat extended duration, as for instance, the more or less standard two weeks' vacation, a definite plan for using the time will be found a great help in obtaining the maximum enjoyment and benefit. There is nothing so boresome as extended idleness. A little sincere thought can make recreation something more significant, more interesting and more enjoyable than it generally now is.

NEW HOPE

There appears elsewhere in this issue, as this month's article of the Technology Series, the story of the Institute grounds and their development. The information found in this article will be of interest to every wide-awake Tech man.

The feelings of the Technology student in regard to the appearance of the Institute buildings probably vary somewhat with the length of his acquaintance with the Institute. His first impression is very likely one of surprise and disappointment at the undisputed barrenness of the grounds. The vast expanse of pebbles and the boardwalks all have such an appearance of being but temporary makeshifts that he almost expects to see work begun upon the development of a more graceful scenic effect at any time. He wonders just what form this development will take and when it will begin.

Then, as time passes and he sees no change made, he gradually comes to accept what seems to be inevitable and he ceases to expect and hope for the needed improvements. He sinks into a more or less complete indifference concerning the whole matter, feeling probably that, "Oh, yes, something of that sort will be done sometime; but no one knows when or what."

Whatever a man's feeling on the subject may be, this article will serve to show that plans are made; but that, due to many problems and difficulties, which are not apparent at first thought, these plans are more difficult of fulfillment and require more time for their completion than at first glance seems necessary. And so there is indeed the prospect of seeing sometime in the not too distant future a Technology that shall be as beautiful in its external appearance as we know it to be complete in its internal furnishings.

MEETINGS AND CONVENTIONS

A. I. E. E. Meeting of Worcester Section: November 16 — Paper on electric meters, their principles of operation, installation, and use, by Messrs. C. P. Knight, G. M. Hardy, and others. December 21 — Paper on the principles of vacuum tubes, by H. H. Newell.

A. S. M. E. New Haven Section: November 20 — Steel Point Power Station Meeting; joint meeting with the Bridgeport Branch and the Connecticut Branch of the A. I. E. E.

Metropolitan Section. November 14. In Engineering Societies' Building, New York City. Subject: Economies of Coal Storage.

Paterson-Passaic, N. J. Meeting. Subject: "Textiles."

A. C. S. Rochester Section: November 20 — Dr. W. K. Lewis, of Massachusetts Institute of Technology, will speak.

B. S. C. E. Designers' Section: November 8 — "Handling Material by Conveying Machinery," by Nixon W. Elmer, Consulting Engineer in Conveying Machinery.

A. A. E. Boston Chapter: November 10 — Regular Monthly Meeting.

N. E. W. W. A. Boston City Club: 1.00 *P.M.*, November 14 — Dr. Richard Moldenke, Consulting Metallurgist will present a paper on the general subject of "Iron Castings." Motion pictures of the "Centrifugal Process of Casting Pipe" taken at the New Birmingham plant of the U. S. Cast Iron Pipe and Foundry Co., will be shown. S. R. Church, of the Barrett Company, will speak on "Tars."

A. S. C. E. Northeastern Section: November 18 — Luncheon Meeting; Boston City Club, 1.00 P.M.

RECOMMENDED ARTICLE

The Parsons Steam Turbine, Scientific American, October 1922. The steam turbine has become so familiar to all engineers that they are apt to forget the fairly recent development of this remarkable engine. Mr. Parsons, like all inventors, passed through a period of struggle and misfortune before he could gain recognition for his machine, but success crowned his efforts in the end and his engine is now used in a variety of capacities.

SHOULD TECHNICAL EDUCATION BE AMELIORATED?

(*Continued from page 137*)

students do have their rooting; and I look to see the college graduate of the future meet every crisis in life as he learns to meet the crises on the grid-iron — by jumping up and down and yelling!

Consider the wonderful capacity of the Wild Indian for long continued and strenuous effort in hunting, fishing, and raiding. Surely the Indian is not as lazy as he appears to be in his Agency Home on a Reservation! And every one knows that our young men are not stupid, although it is as difficult to persuade young men to study as it is to persuade Agency Indians to plow, and for exactly the same reason. Studying, and especially the studying of science, is as new to us as plowing is to Indians. The great grandfathers of most of our college students could not even read or write, and it is absurd to expect college boys to study because they like to study or because they have an instinctive appreciation of the necessity of studying. No, carrying-on in college must depend mainly on the will-to-study based on a conviction of its necessity, and this conviction must come from the friendly counsel of older men and be reënforced by a sustained demand on the part of the college.

But, many people ask, is study, especially the study of science, a necessity? Certainly not, if there is any alternative; and, of course, there is an alternative. Imagine a never-to-be-escaped human need of a twenty-foot arm. What age-long development and what infinite pains! It is easier to build a steam shovel. This no one will deny, and it means that mankind is now bent decidedly, for better or for worse, towards what has been called social inheritance as opposed to organic inheritance; but social inheritance has its pains, too, as many know who burn the midnight oil.

"Woe to those who are young!"

It is a common belief that youth means only care-free joy, but this blissful state is for childhood only. The divine quality of youth is enthusiasm, and as enthusiasm has in the past led young men to the terrible sacrifices of war, so enthusiasm alone can lead young men to accept the increasing burdens of preparation and training which the new kind of war, called civilization, demands. Woe to those who are young!

How shocking to substitute a materialistic love of steam shovels for a tender-minded love of science for its own sake, and to make study appear as a dire necessity rather than a pure delight! But study is a distressing thing to most young men. Let us face the fact, for nothing else can help us in our dealings with young men. You can fool all of the people part of the time and part of the people all of the time, so it is said; but our young men, they never can be fooled at all.

But, many people ask, is an exacting constraint really necessary in the teaching of science? It certainly is; constraint and not a little coercion. It would be a great boon to education if some clear understanding of this fact could be given to all men. Everyone feels the constraint which is placed on the lives of men by the physical necessities of the world in which we live, and although in one way this constraint is relieved by the advancement of the sciences, in another way it grows ever more and more exacting. It is indeed easier to cross the Atlantic Ocean now than it was in Lief Ericsson's time; but consider the discipline of the shop, and above all consider the rules of machine design! Even the hardy Norsemen never knew anything as uncompromisingly exacting as these.

Every person with whom I have ever talked, old or young, theorist or practician, student-in-general or specialist in whatever line, has exhibited more or less distinctly an attitude of impatience towards the exactions of this or that phase of the precise modes of thought of the mathematical sciences.

"There, alas, the spirit is constrained,
and laced in Spanish corslets."

It is no wonder that easy-going believers in liberal education have always looked with horror on the sciences, very much as softened men and women look upon work. Liberalism means freedom, and "liberalism in education is the freedom of development in each individual of that character and personality which is his true nature." This I accept in a spirit of optimism, believing men's true natures to be good; but there is a phase of education which has but little to do directly with character and personality, and I call attention to this conception of liberalism in education in order that I may turn sharply away from it as an incomplete conception which to a great extent excludes the sciences. There is a condition in education which is the antithesis of freedom; for the teaching of the sciences is a mode of constraint, a constructive discipline without which no freedom is possible in our dealings with physical conditions and things. The study of elementary science is a reorganization of the workaday mind of a young man, as complete as the pupation of an insect, and an exacting constraint is the essential condition of this reorganization.

There is a kind of salamander, the *axolotl*, which lives a tadpole-like youth and never changes to the adult form unless a stress of dry weather annihilates his watery world. Ordinarily he lives always and reproduces his kind as a tadpole, and a very funny-looking tadpole he is, with his lungs hanging as feathery tassels from the sides of his head; when the aquatic home of the *axolotl* dries up, however, he quickly develops a pair of internal lungs, lops off his tassels and embarks on a new mode of life on land.

Something not wholly unlike the change that overturns the world of the *axolotl* seems lately to have come upon the world of men, for our modern age of science and organized industry is like a stupendous drought in its effect on the fine arts and on all the fine old ways of life. Millions of men do indeed continue to live as tadpoles, not very contentedly, it is true, and those who develop beyond the tadpole stage do so only because they meet the great stress of dryness with a quick and responsive inward growth. The study of science is to a very great extent an "inward growth," or what we may call "making up one's mind" in the sense of putting one's mind in order. It is the setting up of exact definitions, the formulation of precise ideas, and the building up of elaborate points of view. Nothing is so essential in the acquirement of scientific knowledge as the possession of precise ideas because nothing else so effectually opens the mind for the perception of the simplest evidences of a subject.

The necessity of precise ideas! Herein lies the impossibility of compromise and the necessity of constraint. One must think so and so, there is no other way. And yet there is always a conflict in the mind even of the most willing student because of the narrowing influence which precise ideas exercise over our vivid and primitively adequate sense of physical things. This conflict is perennial, and it is by no means a one-sided conflict between mere crudity and refinement, because refinement ignores many things. Precise ideas not only help to form our sense of the world in which we live, but they inhibit sense as well, and their complete and unchallenged rule would indeed be a stress of dryness.

An extremely remarkable thing in science is that highly complex penetrating interpretations are forced upon the almost unthinkably meager data which we obtain directly through our senses. An astronomer, for

(*Continued on page 156*)

This is you—at college

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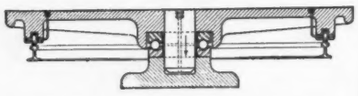

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INDIRECT CALORIMETRY

(Continued from page 141)

of energy. Thus the members of one group before reduction of diet expended an average total heat of six hundred and twenty-six calories to walk ten kilometers, after twenty days of reduced diet they expended five hundred and thirty-three calories or a saving of 14.8 per cent. The expenditure at the end of one hundred and twenty days was four hundred and eighty-four calories or a saving of 22.7 per cent. On the basis of the heat output per horizontal kilogrammeter the normal group averaged 0.597 gram calorie, after twenty days restricted diet it was 0.562 gram calorie, and at the end of one hundred and twenty days the expenditure was 0.522 gram calorie. This was an increase in the efficiency of 12.6 per cent.

This does not mean that we should all reduce our weight and live on a third less ration, although it would undoubtedly be better for many persons of overweight to do so, but it does show that in times of stress the food supplies could be materially conserved by such a reduction without any ill effects for the average worker.

This method of measuring the needs of groups of workers has been carried out to a considerable extent in England and in France it has been applied especially by Amar to the study of the reconstruction of the wounded soldiers. It also finds a valuable application in modern medicine in the study and diagnosis of certain diseases such as diabetes and exothalmic goitre. Today all up-to-date hospitals are equipped for measuring the metabolism of the patient by the aid of indirect calorimetry.

RADIO CENTRAL TOWERS

(Continued from page 143)

in this load falls, the other section of cross-arm was raised, turned, and connected. Then the strains in the load falls were released and the rigging dismantled. The time spent in raising and connecting the two sections of cross-arm in calm weather was about four hours.

The base, body, and cross-arms of a tower were erected by a gang of fifteen men in about eighteen days, though the best record made was fourteen and one-half days. Three towers were erected at one time.

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Strom BEARINGS

"Wherever a Shaft Turns"

TECHNICAL EDUCATION

(*Continued from page 152*)

example, looks at a speck of light as it crosses the field of his telescope and he listens to the beats of a clock, noting the time of day when the speck of light crosses the center of the field. He then looks at a set of finely engraved lines on a divided circle, noting the angular distance of the speck of light above the horizon. All this he does three times in succession. Then, proceeding to interpret his data, he calculates when the speck of light (a comet) will be nearest the sun, how far it will then be from the sun, how fast it will be moving, and when it will return, perhaps a hundred years hence. This kind of forced interpretation is very common in physics and chemistry, and in most cases the actual sense data are so extremely meager that to the layman they seem to be absurdly inadequate.

Another equally remarkable thing in the physical sciences is that we have learned to exercise over physical things a kind of rational control which greatly transcends the cunning of the most skillful hand.

Francis Bacon long ago listed in his quaint way the things which seemed to him most needful for the advancement of human knowledge or power, and, among other things, he mentioned "A New Engine or a help to the mind corresponding to tools for the hand;" and the most important aspect of the modern mathematical sciences is the aspect in which they constitute a realization of Bacon's idea. These sciences do certainly constitute a New Engine which helps the mind as a tool helps the hand, and it is this Engine which makes possible all forced interpretation and all rational control.

This New Engine is in part a mechanical structure. Consider, for example, the carefully planned arrangement of apparatus which is set up and used in any experimental study in the laboratory or in making any kind of engineering test. Experimental data which are in themselves as meager as the astronomer's data take on meaning and bear a complex interpretation very largely because of this arrangement of apparatus. Or consider the carefully planned series of operations of solution, reaction, filtering, drying, and weighing such as is always carried out in chemical studies and tests. The experimental data of the chemist are as meager as the astronomer's data and they take on meaning and bear a complex interpretation very largely because of the carefully planned operations, and, of course, a carefully planned group of operations is essentially a mechanical structure.

The New Engine is also in part a logical structure, that is to say, a closely reasoned body of mathematical and conceptual theory.

These two structures do indeed constitute a new engine, and the teaching of the physical sciences is the building of this engine: (*a*) By developing the logical structure of the sciences in the mind of the young man, (*b*) by training in the use of instruments and in the performance of ordered operations, and (*c*) by exercises in the application of these things to the phenomena of physics and chemistry at every step and always with every possible variation.

That certainly is an exacting program, and the only alternative is to place the student under the instruction of Jules Verne where nothing is to be done. There the student need not be troubled by exactions, but he can follow his teacher pleasantly on a carefree trip to the moon, or with easy improvidence embark on a voyage of of twenty thousand leagues under the sea?

"Superiority to fate
Is difficult to learn,
'Tis not conferred by any,
But possible to earn
A pittance at a time,
Until, to her surprise,
The soul, with strict economy,
Subsists till paradise."

The most distressing idolatry the world has ever known is the modern, popular science-worship which pays no tithes and takes no pains. It is our Great Religion. Its catechism is science teaching which abhors exactions; its litany is the semi-serious wail of regret of our easier college graduates that a silver-spoon smartness was not transmuted by a pleasant college

(*Continued on page 158*)

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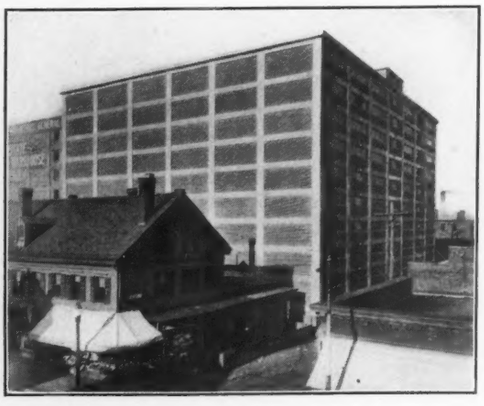

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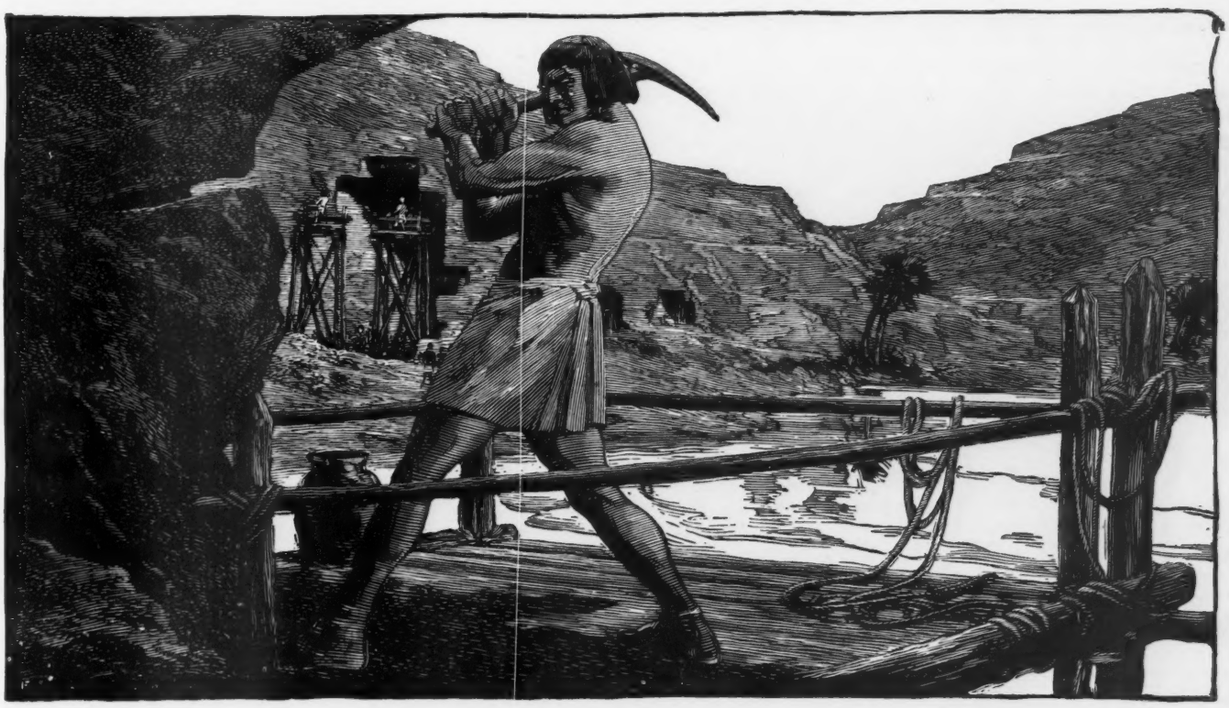

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TECHNICAL EDUCATION

(Continued from page 156)

course into what they conceive the talents of its priesthood to be; and its creed is the belief of every would-be parasite who thinks exaltingly that science is the building of steamships to carry him where he has no need to go, of railways to bring him things he could better do without, and of airplanes to carry quickly his letters which would not lose in meaning if their time of transit were to take a thousand years. Most people think of science in terms of its results, chiefly, indeed, of results which facilitate joy-riding of all kinds, including easy orgies of near thinking. And these are the Beatitudes! Blessed is the joy-rider, for he shall not run amuck! Blessed is the nation of joy-riders, for it will stand — until the next great war. In view of such bliss it is, of course, absurd to count humanistic things such as literature and art as safeguards against reversion to savagery.

No! Science is Finding Out and Learning How. Its greatest gift to those of us who live inside of its frontiers is an understanding of the things which surround us and of the things we have to do. Its price is pains.

Science is finding out and learning how, but its results have fascinated the crowd, who, neither paying nor achieving, adopt a scale of material values for everything in life with a consequent neglect of human quality and a denial of human value in everything. We have a wisdom of easy plausibilities, a religion of mechanical beatitudes, a theology of universal indulgences, a jurisprudence which will hang no rogues. All of which means that we cannot discern worth or unworth in anything, and least of all in men; whereas nature and heaven command us, at our peril, to distinguish worth from unworth in everything and most of all in men. Our real problem now, as always, is "Who is best man?" and the fates forgive much — forgive the wildest, fiercest, and cruelest experiments, if fairly made in the settling of that question. Theft and blood-guiltiness are not pleasing to the gods, and yet the favoring powers of the material and spiritual worlds will confirm to you your stolen goods and the noblest of voices will applaud the lifting of your spear if only your robbing and slaying have been done in fair arbitrament of the question "Who is best man?" But if we refuse such inquiry we come at last to face the same question wrong side upwards, and our robbing and slaying must then be done to find out "Who is worst man?" which, in our wide order of inverted merit, is a difficult question, and its decision is a Denial:

"Ich bin der Geist der stets verneint,
und das mit Recht, Denn alles was
entsteht ist werth das es zu Grunde
geht." — *Mephistopheles.*

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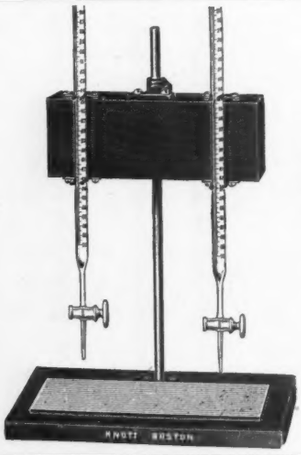
Astronomers at the Harvard Observatory Station in Arequipa, Peru, have measured the distance from the earth and the size of the Large Magellanic Cloud. The "Cloud" is a group of stars and nebulae resembling the Milky Way and is believed to be a small universe in itself although of staggering dimensions. The "Cloud" is 110,000 light years from the earth and contains stars 10,000 times as bright as the sun. A light year is six trillion miles. Professor Solon I. Bailey is in charge of the observatory and has discovered through a study of photographic plates over 2000 new nebulae, several new stars.



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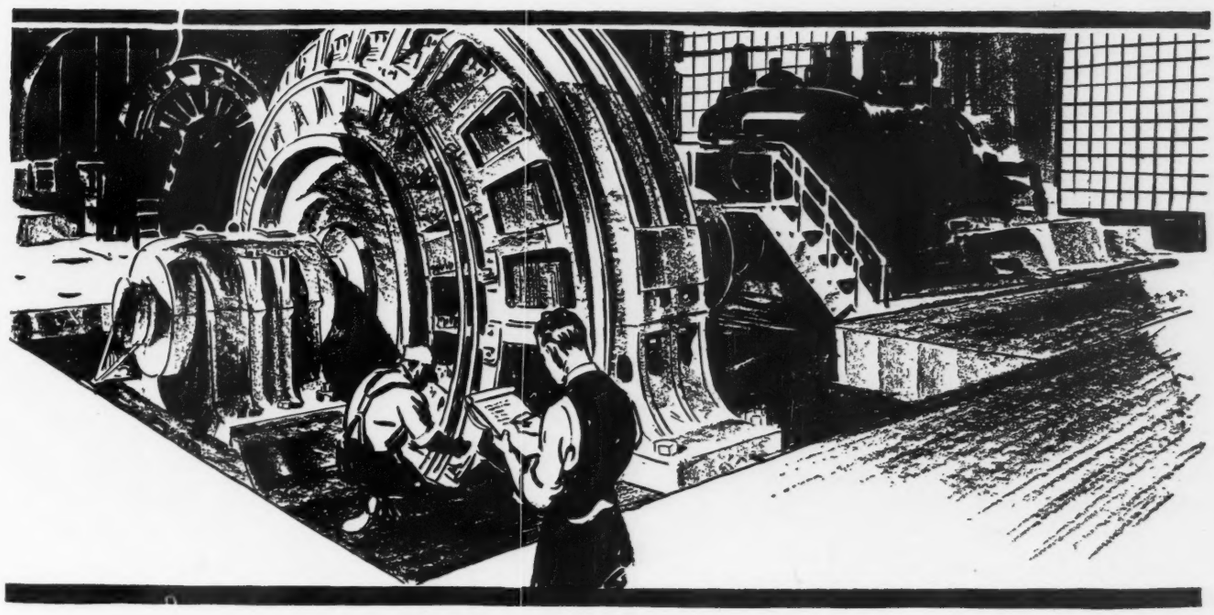

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Be glad that you are to live and work in times when the spirit of service dominates commercial operations. The greatest change that has occurred in business in the last few decades has been in the minds of men. No longer need the buyer beware for it is now known that the seller's obligation reaches beyond the completion of the sale; and that it is both wise and right that every reasonable effort be made to give the buyer full value in both product and satisfaction. The practise of this policy requires engineering of the highest type in research, design, manufacturing and every other phase of Westinghouse operations, but nowhere to greater degree than in the field of application engineering, which is essentially engineering for the buyer.

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AMERICAN SAILPLANE

(*Continued from page 145*)

third, a skilled pilot able to use the available wind-puffs to the utmost advantage. Once altitude has been attained through soaring on the rising currents, the sailplane assumes its normal angle of descent and glides until fresh winds avail themselves for further soaring.

Motorless flight may be represented graphically by the accompanying drawing. The ordinates to the curve represent relative wind velocities and the ordinates to the sailplane represent relative altitudes of the machine while the abscissae in both cases indicate the time elapsed since the take off. It is seen that air-yachting consists in general of an alternation of soaring and gliding.

After all, the airplane like most of our mechanical devices is an inefficient thing. Motorless flight in the strict sense of the term can never be more than a sport. The practical problem involved, however, is not that of remaining aloft without the expenditure of energy but the problem of utilizing existing meteorological conditions to accomplish the maximum work with the least expenditure of artificial power. Forecasts point that the outcome will be more efficient airplanes and small low-powered sport planes of ten horse power or less.

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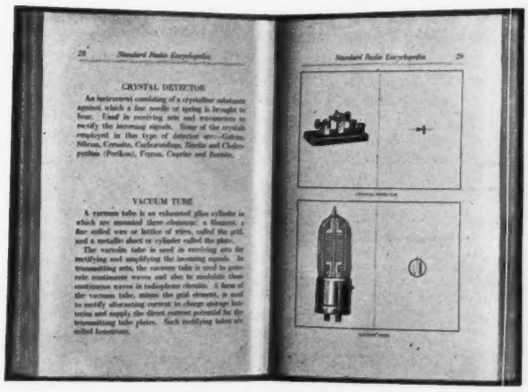

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TERMINAL PROBLEMS

(*Continued from page 144*)

compared with more than one-half in Chicago; that is, traffic having no business in the city proper. More than two-thirds of the total car traffic is interchanged between the roads and two-thirds of this is done on the congested waterfront, while only one-fourth of that car movement is direct export and import movement. In other words, city business and marine business is hopelessly interlocked in the attempt to carry on both in the same location. This emphasizes an important premise — that the waterfront is not the place for city business, nor is it the place for rail clearing or storage operations.

Railroading is a continuous function; shipping is an intermittent one. The difference in the turn around time in boats and cars must be met by reservoir capacity. If it is not provided, every harvest time will result in a vast car movement to the seaboard, the clogging of the terminals, and a serious shortage of merchandise cars in the interior. The coal problem is similar. One 10,000-ton cargo would require three miles of cars standing, 2,000 or 3,000 truck loads, or eight miles of trucks in line. Imagine the activity in a port required to handle twenty cargo ships at a time, with an average five day turn-around (which should be possible instead of ten, fifteen or twenty days turning time). What is needed is more movement, not more cars or ships. It is the cost of idleness that eats up the profits.

The worst feature of the old plan of organization is that city freight facilities have been located parallel to the waterfront, sometimes in rows of platforms or buildings three or four deep. Obviously this makes it impossible to serve the city business adequately without requiring all city trucking to mix in the waterfront traffic and cross the longitudinal or parallel system of tracks which not only creates bad roadway conditions but also seriously interferes with waterfront movement and switching.

Recommendations can briefly be summarized as follows: (1) Terminal rail development should be at right angles to the waterfront in order to facilitate ingress and egress from the city freight houses and team tracks. In other words, the waterfront should be reserved for waterfront business.

(2) The problem should be considered as a whole, as well as in its independent parts, and every effort should be made to save time and cost of transit through the terminal.

(3) The belt line plan seems to be the most practical for inter-terminal transport. In this connection car detention should be reduced to a minimum and railroad rolling stock should not be used for jobbing, warehouse or storage purposes.

(4) The planning should be done under one committee in order to get a unified plan.

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SHOP LIGHTING.

In an address delivered before the members of the Western Pennsylvania Division of the National Safety Council, Pittsburg, Pa., March, 1918, by C. W. Price, the importance of good lighting in industrial establishments was discussed, and the disadvantages of poor lighting were clearly shown by some figures mentioned by Mr. Price.

A large insurance company analyzed 91,000 accident reports, for the purpose of discovering the causes of these mishaps. It was found that 10% was directly traceable to inadequate lighting and in 13.8% the same cause was a contributory factor. The British Government in a report of the investigation of causes of accidents determined a close parallel to the findings of the insurance company above quoted. The British investigators found that by comparing the four winter months with the four summer months, there were 39.5% more men injured by stumbling and falling in winter than in summer.

Mr. John Calder, a pioneer in safety work, made an investigation of accident statistics covering 80,000 industrial plants. His analysis covered 700 accidental deaths, and of these 45% more occurred during the four winter months than during the four summer months.

Mr. C. L. Eschleman, in a paper published in the proceedings of the American Institute of Electrical Engineers several years ago, reported the result of an investigation of a large number of plants in which efficient lighting had been installed. He found that in such plants as steel mills, where the work is of a coarse nature, efficient lighting increased the total output 2%; in plants, such as textile mills and shoe factories, the output was increased 10%.

In an investigation of the causes of eye fatigue, made by the Industrial Commission of Wisconsin, it was found that in a large percentage of industries, such as shoe, clothing and textile factories, the lack of proper lighting (both natural and artificial) resulted in eye fatigue and loss of efficiency. At one knitting mill, where a girl was doing close work under improper lighting conditions, her efficiency dropped 50% every day during the hours from 2:30 to 5:30 P. M.

The above mentioned incidents indicate how important a factor lighting is in the operation of the industrial plant. It has been well said, "Light is a tool, which increases the efficiency of every tool in the plant." Glare or too much light is as harmful as not enough lighting, and in no case should the eyes of the workers be exposed to direct rays, either of sun or electric light.

Windows and reflectors should always be kept clean; that is, cleaning them at least once a week, for where dust and dirt are allowed to collect, efficiency of the light is decreased as much as 25%.

Good lighting, in addition to its other marked advantages, is a strong incentive towards keeping working places clean, for it clearly exposes any place where dirt or other material has been allowed to collect. White walls and clean windows glazed with Factrolite Glass will eliminate the sun glare and increase the illumination 25 to 50 feet from the window from 38% to 72% as compared with plain glass.

Lighting is of primary importance to every employer and fully warrants a careful investigation of the subject, for there is no substitute for good lighting, and if it is not supplied the efficiency of the entire working force must suffer a serious reduction.

If you are interested in the distribution of light through Factrolite, we will send you a copy of Laboratory Report—"Factrolited."

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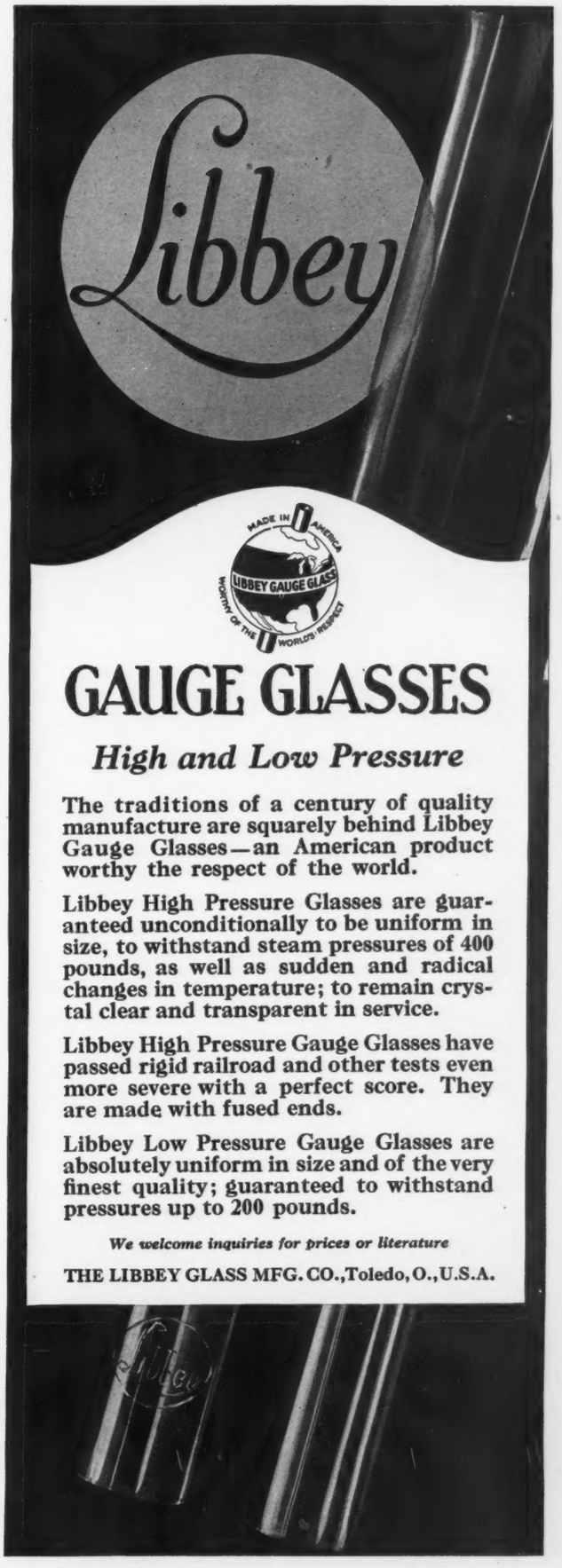
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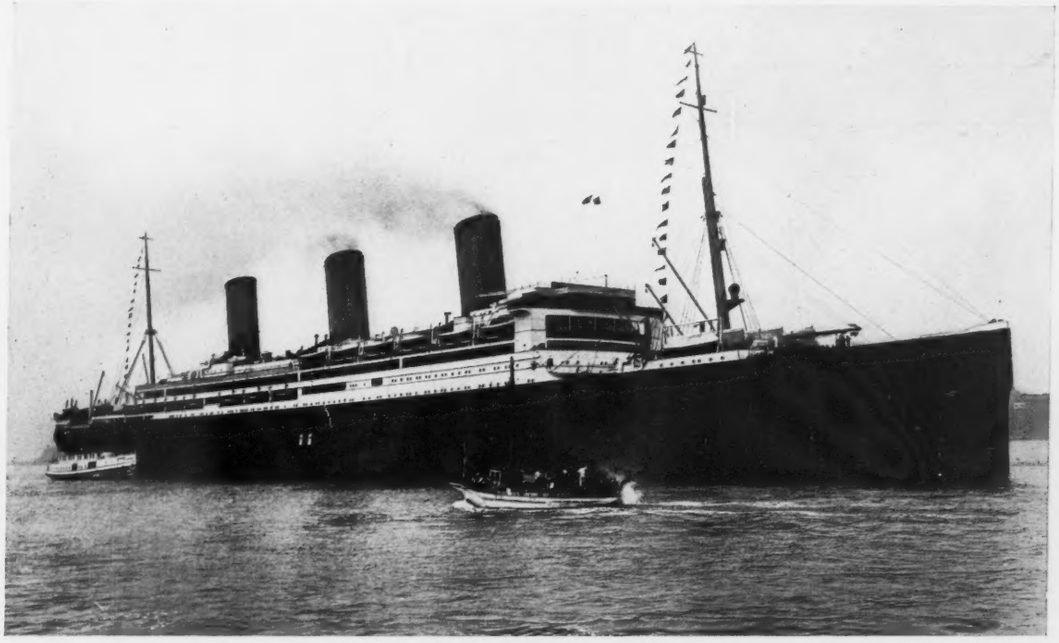

The Forced Draft and Ventilation on the "Leviathan"

For Forced Draft, the Sturtevant apparatus used consists of eight No. 11 Multivane Designs, 3 Blowers each, direct connected to an 8 x 7 Sturtevant VS-7 Engine. Each of these blowers is rated as follows:

C.F.M.	Static Pressure	R.P.M.	H. P.
45,000	2″	285	26
45,000	2½″	300	30
45,000	3″	320	34

For Ventilation the following Sturtevant apparatus is used:

SERVICE	No. of Units	C.F.M. Each Unit	Static Pressure	Size Fan	R.P.M.	B.H.P.
Bath Rooms	2	500	2″	"D"	2100	.4
Shops	2	1,500	2″	No. 2 MV	1400	1.0
Fire Room Auxiliary Ventilation	16	3,000	0″	24″ Prop.	750	.125
Emergency 4th Class Space	8	5,000	2½″	No. 4 MV	975	3.2
Engine Room and Galley	2	60,000	2″	No. 9 MV	450	42
Engine Room	2	17,000	1″	No. 6½ MV	500	6.5

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DE MAGNETE —

"WORD MONGERS" *and* "CHATTERING BARBERS"

"Word mongers" and "chattering barbers," Gilbert called those of his predecessors who asserted that a wound made by a magnetized needle was painless, that a magnet will attract silver, that one diamond will draw iron, that the magnet thirsts and dies in the absence of iron, that a magnet, pulverized and taken with sweetened water, will cure headaches and prevent fat.

Before Gilbert died in 1603, he had done much to explain magnetism and electricity through experiment. He found that by hammering iron held in a magnetic meridian it can be magnetized. He discovered that the compass needle is controlled by the earth's magnetism and that one magnet can remagnetize another that has lost its power. He noted the common electrical attraction of rubbed bodies, among them diamonds, as well as glass, crystals, and stones, and was the first to study electricity as a distinct force.

"Not in books, but in things themselves, look for knowledge," he shouted. This man helped to revolutionize methods of thinking—helped to make electricity what it has become. His fellow men were little concerned with him and his experiments. "Will Queen Elizabeth marry—and whom?" they were asking.

Elizabeth's flirtations mean little to us. Gilbert's method means much. It is the method that has made modern electricity what it has become, the method which enabled the Research Laboratories of the General Electric Company to discover new electrical principles now applied in transmitting power for hundreds of miles, in lighting homes electrically, in aiding physicians with the X-rays, in freeing civilization from drudgery.

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